ually waste away, and the same result will follow the stoppage of the drift at any point, as by the construction of a projecting pier or wall. If the supply of material is ample, drifting will be only temporarily stopped and the general action will continue after the obstacle has been overwhelmed.

To a very considerable extent beaches can be formed, built up or protected by the proper application of the principles outlined. But the action of the wind and of the ocean vary from day to day. Any attempt to operate continuously in a cycle of forces which exists for but a small fraction of the entire season will result in failure. Beach protection and building works must be based on that action which will throughout the season balance the slow accumulation of favorable weather against the rapid depletion during periods of abnormal action.

Typical Sea Walls

In Fig. 1 are shown a number of the important coast defenses in Europe, a few American walls and a design proposed by the writer. For simplicity in comparison these have all been referred to the high-water line and reduced to the same scale. The material and slope of the beach, taken with the range of the tide and the nature of the backfill, cause a wide variation in the dimensions of the walls, but they show on the whole a rather definite tendency to the use of a general outline which conforms to the theoretical requirements.

Details of a Shore Protection

A sea wall is a retaining wall so built that it will successfully hold a distributed backfill on one side and an intermittent water load on the other. It must be firmly founded and so built as to possess the greatest possible homogeneity. The front face of the wall must be arranged to destroy as much of the energy of the wave as possible before it reaches the upper portion of the wall. No live water must be allowed to fall back of the wall.

A curved reinforced-concrete deck slab of variable thickness on a series of reinforced beams carried on piling can be made to answer every requirement of the problem in a more elegant manner and at a less cost than can a structure of any other material. In Fig. 2 are given the details of such a wall designed by the writer, which, it is believed, best satisfied the requirements of a coast defense, as outlined below.

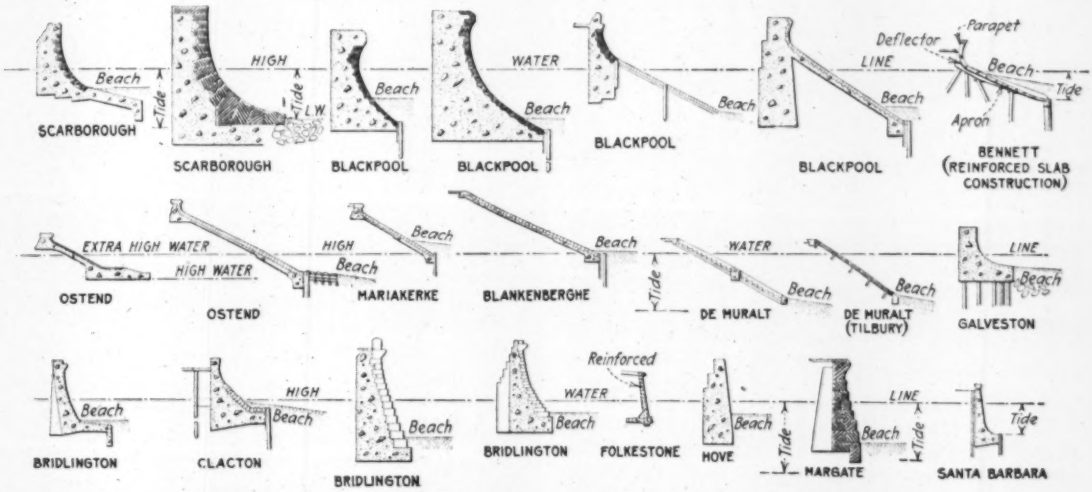

FIG. 1. SECTION OF TYPICAL EUROPEAN AND AMERICAN SEA WALLS
Drawn to same scale

Location	Material	Beach Protection	Apron	Deflector	Parapet	Remarks
Blackpool	Masonry		Sloping	Curved	Projects	Three similar types
Bridlington	Masonry	Groins	6 ft.	Curved	Projects	Several similar types
Blankenberghe		None	A long flat slope of stone on concrete Slope 1 on 2.3			
Clacton	Masonry	Groins	Yes	Slanting	Projects	
Dyn-church	Masonry	Groins	Sloping	Curved	None	
Felixstowe	Wood on concrete	None	None	9 ft.	None	
Folkestone	Reinforced concrete	None	None	Slant 6 on 1	None	Vertical slab rock faced
Hastings	Masonry	Groins	None	8 on 1	Projects	
Hornsea	Concrete	Groins	None	5 on 1	Sets back 10 ft.	
Hove	Masonry	None	None	8 on 1 stepped	None	
Herne	Wood	None	None	9-ft. wall	None	
Leven	Masonry	None	None	2 on 1	Vertical	
Mariakerke	Masonry	None	Slope	Curved	Overhang	
Margate	Masonry	Groins	Sheet piling	8 on 1	Retreating	
Morecamble	Concrete	None	None	Slight curve	Vertical	
Ostend	Masonry	None	Sloping	Curved	Overhang	
Scarborough	Concrete	None	Sloping	Curved	Vertical	
Scheveningen	Concrete	None	Sloping	Curved 1 on 4	Vertical	
Tilbury	Concrete		Sloping	Sloping	None	Stepped concrete
Trusthorpe	Wood	None	Sloping	Sloping	None	

A complete coast defense will have, inside of a fringe of long groins, three distinct wall portions combined in one interlaced and homogeneous structure. There must be the groins, an apron, a deflecting wall, and an upper wall, or parapet. The purpose and details of each of these parts is explained in the following paragraphs:

Groins

The term groin is used to designate any ridge, wall or fence run into the sea in a direction more or less perpendicular to the coast line for the purpose of controlling littoral drift. At one time massive masonry walls were used for the purpose. Some portions of the Netherlands coast are still protected by flat masonry ridges running well into the deep water. So far as its action is concerned, the material of the structure is of little importance, and most modern work is of wooden construction.

When the history and working forces of a stretch of coast have been properly studied, it is possible to make studies of the comparative effect of various spacings, heights and lengths. In general, the preferred system will start above high water or at the face of the sea wall and extend to below low water. The groins will at first be of nominal height, but the posts will be arranged for carrying the work up as sand accumulates. The most stable beaches are usually formed by low walls, which catch without difficulty sufficient sand to completely cover themselves and allow all excess material to flow past. Thus they maintain the leeward beaches without erosion and cause the least possible change from the natural beach slope and outline.

The entire intention of a groin system is to confine all the littoral material that is needed for any given section of the shore within rather narrow but certain limits lengthwise of the beach. Seas can enter the pockets between the groins only at the lower end and must travel

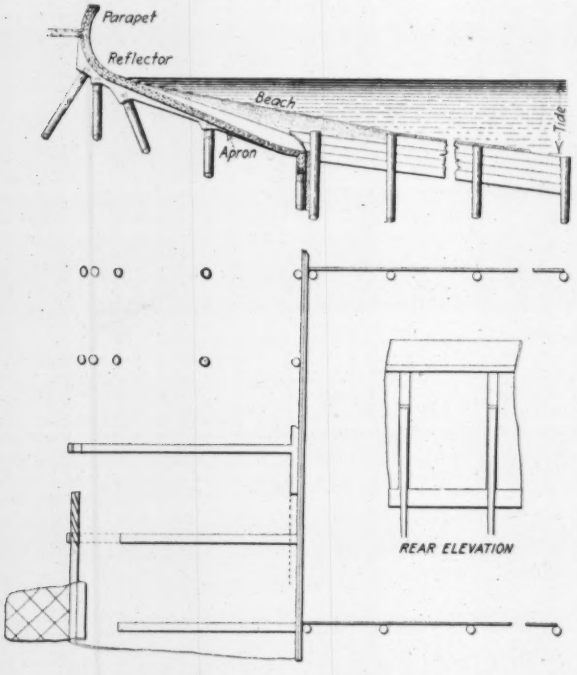

FIG. 2. PROPOSED SHORE PROTECTION

more or less parallel to the walls in running up the beach. Material moving under the influence of the ocean in this zone can travel only up and down the slope of the shore. If just sufficient in quantity it will wear down under water in times of severe seas and store on the upper beach in quiet seasons.

In reality this ideal condition can never be attained. Much of the material carried down in storms passes beyond the control of the groins and is carried away by the longshore currents. Some of the sand left on the upper beach dries out and blows away unless held by a wall.

There is a slight action, even between the walls, of the littoral currents, and so a depletion of beach occurs next to the leeward side of every groin and an accumulation on its windward face. As soon as this accumulation becomes higher than the wall, the littoral drift is reëstablished and there is a flow of material into one end of the series of groins and a corresponding outflow at the other end. If the source of the material is still active, the normal flow will now be secured.

That spacing of groins which will be suitable for the proper underwater beach conditions may not be close enough to hold the upper beach sands to as true a plane lengthwise of the coast as is desired. Short intermediate or inshore groins can then be introduced to advantage.

On ordinary coasts the main groins will extend from the sea wall or the high tide straight out to beyond low tide. They will be spaced their own length apart, will have the same slope as the beach naturally has and will not project more than a few feet above the sand when erected.

Shape of Sea Wall

The upward range of the seas, the drift of the upper beach sand and the cliffs or embankments of the shore must all be fixed at some definite point by a stable structure. The maximum pressure of the wave action is applied to the area on which the crest of the wave, the breaker, falls. If the sea wall is hard, smooth and impervious, no internal shocks occur. If it is properly shaped, no secondary shocks due to projecting faces or pockets are possible. The time of application is very brief, for the wave has a transitory motion of many feet per second. So the surface of the sea wall is subjected to a series of rapidly moving zones of pressure from the waves and to a more or less intermittent water pressure corresponding to the depth of water behind them, while there is applied to the back the constant even pressure of an earth backfill.

The stability of a wall designed to be loaded with a static load on one side and an intermittent load on the other is largely dependent on the proper determination of the static load both as to amount and direction. Such a wall, as a beach protection structure, will probably be backed by sand both on the sea and the land sides. Sand, when wet and agitated, will flow freely, so if there occur any break in such a wall its backfill is likely to be lost and if it discharge water too close to its front serious erosion may take place at its toe.

Foundations

One of the most difficult problems in the construction of sea walls of any type is the securing of proper foundations if the structure is to be built, as is usually the case, on the sands of the beach.

A structure resting directly on sand is only stable if the sand is confined. The sand of the beach is anything but confined before the wall is built, and the placing of a structure in the edge of the sea is almost certain to cause currents that will to some extent scour along its face. Even with proper groins there will be places and times during the restabilizing of beach conditions, or even after, when the sea may tend to cut against the wall. Ground water will start channels and rapidly enlarge them. Sometimes the burrows of animals are enlarged into extensive trenches by water from storms.

The only safe foundation for a sand-founded sea wall is piling. By driving part of a group vertically and part as batter piles an absolutely stable base can be had that will be independent of the superficial wear of the surface sands. This piling may be either wood or concrete. In most cases it will be in wet ground and wood will have a satisfactory life. It is essential that there be a

firm joint between the piles and the concrete and that the piling have a length sufficient to make them safe against dead-load, erosion, uplift, shock and reversal of loading.

Apron

The lowest portion of the sea wall, the apron, must join the sands of the beach and extend their general slope up to the base of the deflector. It must pass the incoming waves on toward the shore without serious disturbance and must receive the back-wash from the deflector and parapet and deliver it to the deeper water beyond without local damage.

Its slope and length should be sufficient to carry the concrete down to low-tide line or to a depth below the permanent beach line sufficient to obviate any chance of scour. The projection of secondary groins on the apron is advantageous, as it tends to limit the sidewise flow and so to prevent depletion of the upper beach.

The thickness and reinforcement of the apron will vary from a minimum at the lower lip to a maximum as the apron approaches the deflecting portion of the wall. At the lower edge the sand blanket will almost always be in position and the slab will need to carry only a well-distributed wave shock. Under this section the underlying sand will almost certainly be in complete contact with the concrete and will serve to support it. Reinforcement will be needed only as a precaution against extraordinary conditions and shrinkage cracking.

Deflector

As the apron extends upward, it gradually merges into the deflector. This section of the wall should consist of a thick, heavy slab, so arranged that all local shocks are distributed to the unloaded portions of the wall. It lies between wind and water. On it much of the energy of the waves is expanded in impact, and it is battered by loose or floating material. It should commence low enough to properly resist such shocks as may occur at low tide and yet be so arranged that it is properly shaped to receive the violent shock of the deep waves which reach it at high tide.

To successfully resist impact it must have a hard yet resilient face and must be, so nearly as may be, non-absorbent, for an absorbent face, alternately wet and dry, will soon begin to flake. The presence of large open joints is extremely undesirable, for through them water under pressure is driven into the interior of the wall and it is subjected to internal as well as external shock. It must be so formed as to be stable even after the loss of backfill behind or beneath it. As it lies high, wave blows will fall, during storms, on its unprotected face. It must be of ample strength and rigidity to handle their maximum concentrated load without failure.

The shape of the curve of the deflector should be determined by the height and shape of the maximum waves that will beat against it. The lower edge must join the slope of the apron with an easy sweep along which the back wash from the wall will flow without tending to cause shock or scour. When the most severe seas are attacking the wall at high tide, the curve at the point of tripping should be such that the water will either fall on a cushion formed of water from the front edge of the wave, or will slide up the face of the wall with little or no local shock. As the conditions here vary a great deal, the ordinary result against a well-proportioned wall is a mixture of the two actions. The cushioning on disturbed water is probably the most advantageous method of receiving wave shock, but it is also the most difficult of accomplishment against a steep-faced wall. As the wall is at this point curving rapidly to join the parapet above, many of the waves must impinge on the steeper portions.

Parapet

After the direction of the water movement has been changed from the horizontal to an inclined upward sweep by the deflector, the final direction of its course is taken care of by the parapet. In general, there will be a gradual outward curve, so that when the water has passed beyond the wall and has reached its maximum height it will fall back into the sea and will not, even during an onshore gale, fall heavily on the landward side of the wall. If the discharge is properly made, the spent water can be thrown so far toward the sea that it will fall on the water surface and dissipate its energy in breaking up the incoming surf.

As this curve must sometimes be separated from the deflector by a stretch of flat or nearly flat wall, it must start to overhang at a very gentle rate, but it can curve at an increasing rate as it gains in height. But a short abrupt curve will not control a wave of any considerable thickness. If the surface is smooth, the curves gradual and the entire structure of ample height, the parapet will be but little buffeted by the seas. It can be built with a rapidly decreasing thickness as it rises from the deflector.

Motor-Bus Lines to Pike's Peak—A new motor-bus line is scheduled to run between Colorado Springs and the summit of Pike's Peak. The buses will be operated in competition with the old cog railroad, a new highway having been built from Cascade to the Peak. For this service, which will be inaugurated on July 15, the White Co. of Cleveland, Ohio, is building twelve 12-passenger motor buses and three 7-passenger touring cars. The new highway is 17 mi. long, 20 ft. wide, with no grades exceeding 10 per cent. At the summit the elevation of the road is 14,109 ft., making it the most lofty highway in North America. Only one other road on the Western Hemisphere exceeds this altitude, and that road, which crosses the Andes Mountains in Bolivia at an elevation of 17,000 ft., is also the route of a White bus line. The Pike's Peak highway is constructed with many wide turnouts and view stations. The road will be open to all kinds of motor vehicles and automobile supply stations will be located at convenient points. A round trip can be made easily in five hours, and the schedules of the buses will include trips at sunset, sunrise and moonlight.

Four Years' Record of the operation of the 33 electric locomotives in service on the New York terminal division of the Pennsylvania R.R. shows 3,974,746 locomotive miles, 45 engine failures, 271 minutes total train detention, 88,328 locomotive miles per detention, 14,667 locomotive miles per minute detention, 463,558 train movements, and 1300 train movements per engine failure. This type of locomotive was described in "Engineering News," Nov. 11, 1909. Briefly the design shows two half-units, each having a four-wheel bogie truck and two pairs of rod-connected drivers, coupled with a knuckle joint at the driving-wheel end. Each locomotive in service passes over an inspection pit every 24 hr., when a running inspection of machinery is given and slight repairs are made where necessary. The average time required for this inspection is approximately 10 min. After 3000 mi. of run the locomotives are taken into the shop for a general inspection, when all electrical apparatus is thoroughly looked over, tested, cleaned and, when necessary, adjustments and renewals are made to all electrical and mechanical parts. The "shopping" of these locomotives for general repairs is governed by tire wear. A number of locomotives have run from 90,000 to 112,000 mi. before it was necessary to turn the tires or make any general repairs.

Two Large Irrigation Projects in Russia--II

By Milan Nikolitch*

SYNOPSIS—The Mugan Steppe Irrigation Project comprises 465,000 acres bordering the Caspian Sea. The water-supply is from the Arrax River, which presents river-control problems similar to the Colorado River in its relation to the Imperial Valley, southern California. The Mugan Project comprises four independent canal systems. The Golodnaya Project was described in Engineering News of July 1, 1915.

The southeastern portion of Caucasia, composed chiefly of the lower parts of the Kura and Arrax Valleys, approximates in its character the central Asiatic plains. High mountains of Caucasia and the Armenian Highlands fringe the valleys on the north, west and south. The eastern border is formed by the Caspian Sea, into which discharge two main rivers of the region, Kura and Arrax. Both rivers drain an area of about 70,750 sq. mi., consisting chiefly of mountains and having heavy precipitation. The lower part of the valleys has the character of the dry steppe, the rainfall being not sufficient to support the plant life promoted by high summer temperatures.

Where the irrigation did not require great engineering skill, the valleys have been irrigated by the natives; but the greatest part on both sides of the Kura and Arrax is still untouched, awaiting larger expenditures of brains and money than the natives can make.

The Mugan Steppe is only a portion of the total area needing irrigation. It occupies the most eastern part of the Kura and Arrax valleys, forming nearly a square between these rivers, the Persian boundary and the Caspian Sea.

In a not very remote period, according to some authorities, the area of the Mugan Steppe was covered with the waters of the Caspian Sea, which gradually receded, as they are receding now. In fact, the greatest part of the Mugan Steppe is situated below the level of the Black Sea, which in former days was connected with the Caspian Sea, but which now lies about 85 ft. above it.

The rivers Kura and Arrax, which emptied into the sea in this place, contributed by their silt deposits to the formation of the continent. The Arrax River has played in the formation of the Mugan Steppe the same part as did the Colorado River in the Imperial Valley in southern California, and the same problems of irrigation and river control that present themselves in the Imperial Valley may be found here too.

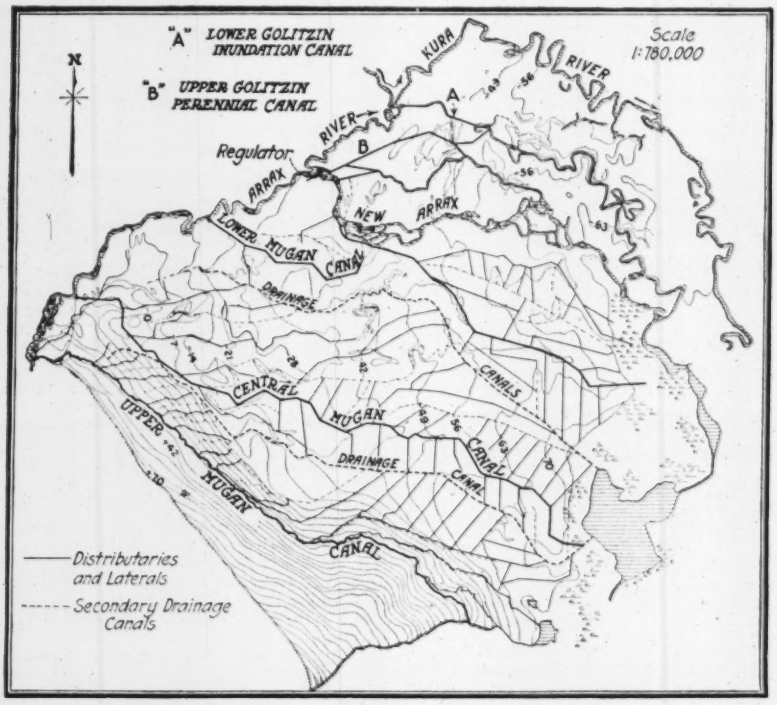

FIG. 1. MAP OF MUGAN STEPPE IRRIGATION PROJECT, RUSSIA

The Lower Mugan Canal was extended to take the place of the unnamed canal shown as heading in the New Arrax River. No canal is taken out of the stream just named

Each river carries a large amount of suspended matter, which is deposited either at the mouth of the Kura or is spread over smaller or larger areas of the steppe during the high-water period. This is especially true of the Arrax, which annually floods its banks. Owing to low banks and the fine material of which they are composed, this river has several times in the recent history of the Mugan changed its course and flooded enormous areas of the steppe, creating a chain of lakes and always leaving new layers of silt when the water receded. The last break which had a bearing upon the irrigation works in this region occurred in 1896. This time the break remained until 1908, when it was closed by a modern structure and the river turned into its old channel.

The water-supply for the irrigation of the Mugan Steppe is obtained from the Arrax River. This river rises in the mountains of Turkish Armenia, not far from the origin of the Euphrates River, which has a western and southwestern course toward the Persian Gulf, while the Arrax follows an eastern direction to the Caspian Sea. The upper portion of the drainage area, which measures about 35,000 sq.mi., is composed chiefly of high mountains, among which Mount Ararat reaches 17,000 ft. The total length of the river is about 600 miles, of which about 240 miles form the boundary between Persia and Russia. The lower portion of the drain-

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area is occupied by semi-desert plains generally called the Milsk and the Mugan Steppes. The Milsk Steppe is situated northeast of Arrax. The Mugan Steppe occupies the southeastern part. At present the Arrax River empties into the Kura River. In the past it often changed its course and on many older maps its mouth is shown independently of that of the Kura. The discharge of the Arrax has not been sufficiently observed to give a good idea of its flow for a long period. It is only known that the maximum discharge is about 35,000 sec.-ft. and that the minimum flow has been as low as 858 sec.-ft. In the following table are given the maximum, minimum and mean discharges for three years, all in second-feet:

Year	Maximum	Minimum	Mean
1903	15,100	3040	6650
1904	18,250	3020	6900
1912	35,000	2990	....

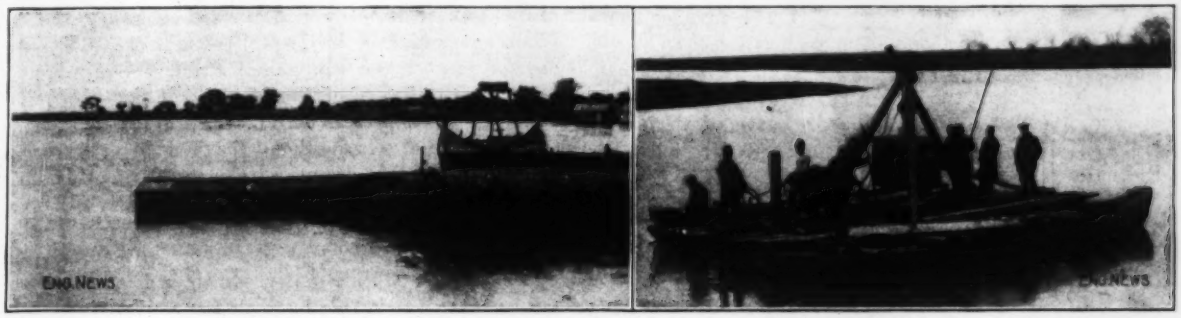
Regarding the high-water period, Arrax differs somewhat from other large Turkestan rivers, where the high-water period covers almost the whole irrigation season. Here the high water begins in March after heavy spring rains and melting of snow, reaches its maximum in May, and ends in June. July and August are the months of the minimum discharge. It follows that the low-water period coincides with the period of least rainfall. The river brings a large quantity of silt from the higher parts of its watershed. With the diminishing slopes in the Mugan, a part of the silt is deposited in the steppe, while the other is taken down to Kura and used for building up the delta at the mouth of that river. The experiments made by different authorities who have been engaged in the investigation work in the Mugan show that the river carries in the spring about 1.12% of silt by weight, and in winter about 0.3% by weight. The silt of Arrax is recognized as very beneficial to the soil and can be used as fertilizer. But at the same time the river carries a comparatively large amount of dissolved salts, which are deposited with the silt. This is especially true during the low-water period. The amount of dissolved salts in the Arrax water during the spring time is about 21.74 parts per 100,000.

HISTORY—Certain portions of the Mugan Steppe have been irrigated in past centuries, as is witnessed by many remains of old canals; but generally with the passing of the masters of the Mugan the irrigation works were destroyed and abandoned. However, owing to the low banks of the Arrax River and the comparatively easy way of diverting the water from it, the narrow area of about 3½ miles on both sides of the river has been irrigated to the present day, and settled by prosperous Tartars.

During the last fifteen years the northern part of the Mugan (about 81,000 acres) has been irrigated and settled by Russians. The irrigation works have been of rather primitive character, and the canals could only utilize the flood waters. In 1908, the first perennial canals were constructed by means of which the water-supply of the Northern Mugan is assured the year round. To the 81,000 acres were added during the last few years some 384,000 acres, all of which are situated south of the New Arrax.

The total irrigated area of the Mugan amounts to 465,000 acres. It is situated (Fig. 1) between the rivers Arrax and Kura, the upper Mugan Canal and the swamps bordering the Caspian Sea. The ground surface slopes away from the river, the slope in the immediate vicinity of it being about 0.0003. The area is divided by the New Arrax River into two unequal parts. All recent and more important works are included in the area south of the New Arrax.

IRRIGATION SYSTEMS—The total irrigated area is divided into four independent systems supplied from independent main canals. The oldest of these is the North Mugan system, situated between the New Arrax and Kura Rivers. As has been stated, it was completed some years ago and is already settled. The other three systems, the Upper, the Central and the Lower Mugan, have been under construction for the last three years and are nearing completion.



FIGS. 2 AND 3. SPUR CONSTRUCTION TO PROTECT CANAL INTAKES, MUGAN STEPPE IRRIGATION PROJECT
Left—General view of spur. Right—Lowering 3½-ft. concrete block in building spur

HEAD-WORKS—The adoption of four independent systems for irrigating the 465,000 acres has resulted in five independent intakes, all of which are of the same type, The uppermost intake (see map, Fig. 1) is located a few hundred feet below the Persian boundary and about 5½ miles above the intake to the central canal. The third or lower intake is located about 15 miles below the central intake. For irrigating the Northern Mugan two intakes were made, one just above the junction of the Arrax and Kura, and the other at the point of diversion of the New Arrax from the Arrax.

Generally speaking, the head-works consist of an intake channel terminating in head-gates at the head of the main canals. No works whatever are provided for regulating the water surface in the river in front of the head-gates. The intake channel is not less than 2100 ft. in length and is given ample dimensions with the view of partial silting up, which inevitably must take place above the head-gates.

The head-gates are all of the same type. They consist of concrete or masonry abutments and a concrete or masonry floor 3½ ft. thick across the whole width of the

canal. Upon the foundation floor are placed structural steel bents, which support the working platform and lifting apparatus, and between which slide the gates. The bents are placed 5.6 ft. apart and securely anchored to the foundation. The gates are 7 ft. high. They are made either of wood or corrugated sheet iron, and are raised by means of lifting screws or rack and pinion.

The bottom and slopes of the canal below the head-gates are faced with concrete 1.4 ft. thick for a distance of about 90 ft. The intake sill is placed about 4 ft. below the lowest water stand in the river.

CANALS—With the exception of the Northern Mugan, the canal net is very simple. There are three main canals, taking out from the Arrax and running nearly parallel to each other. Owing to almost complete absence of watercourses in the Mugan, no difficult construction work is met along the canal line. The total length of main canals in the Southern Mugan is about 133 miles, and that of distributaries and laterals about 1470 miles. As a rule the main canals have not large distributaries. Very often small laterals take out directly from main canals.

The canals are designed to suit the discharge of the river, which is variable throughout the summer. In the spring, when the discharge is great, the discharging capacity of all three canals is about 5192 sec.-ft. It seems to be proved by practice that one good irrigation in the spring is sufficient for growing a good crop in the Mugan. Therefore, during the dry summer months, when the river carries its minimum, the discharge of the canals will be reduced to a minimum sufficient only to satisfy the most vital needs of the population. The mean discharge of the canals is computed to be about 3600 sec.-ft.

DRAINAGE SYSTEM—Practically all land along the lower Arrax is subject to overflow, and at the present time is protected by levees. All this area needs thorough drainage, as is also true of the rest of the irrigated Mugan, where on account of small slope and lack of drainage the alkali problem might become very serious. Therefore a complete drainage system is designed and built at the same time as the irrigation system (see map, Fig. 1). The main drainage canals are located in the valley between the main canals, and take care not only of the drainage but also of the surplus water from the irrigation canals. They discharge into lakes and swamps bordering the Caspian Sea.

The river control is one of the chief engineering problems in the Mugan. As already mentioned, the Mugan Steppe represents the delta of the Kura and Arrax Rivers, within which the Arrax meanders with a slope of about 9½ in. per mi. Like the Colorado River below Yuma, the Arrax has several distributaries, through which it has sent the surplus water independently from the main channel to the Caspian Sea, creating always a line of lakes and swamps. In many instances it has entirely changed its course. Such a break occurred in 1896, when the greatest part of the flow went through the so-called New Arrax, leaving the lower 13 miles of the old river bed almost dry. An enormous area was overflowed, and the lakes created at that time are still in existence.

The break was closed in 1908 by a structure known as the Regulator Nicholas II. This structure has been successful in regulating the flow of the Arrax, and has fully justified its cost. The purpose of the structure was not only to close the break and turn the water into the old channel, but also to relieve the lower channel during the flood period and prevent possible damage along the river. The structure is similar in its design to the common type of head-gates already described. Nine masonry piers divide the structure into five bays 33 ft. wide, which are again subdivided by structural-steel bents into four openings, closed by steel gates in much the same manner as the head-gates. The structure is designed to discharge about 12,700 sec.-ft.

The banks of the Arrax consist of alluvial silt, and in many points are overflowed during high stages. The area subject to overflow is protected by an earth embankment. The destructive action of the river in this kind of soil is great, and the bank protection is given serious consideration. On this account the head-gates have been placed 2100 ft. away from the river, and in addition to it the bank above and below the intake is protected by spurs, with the purpose of diverting the current from the bank. The spurs, one of which is shown in Fig. 2, are made of concrete or masonry in cubes 3½ ft. wide, which are lowered into position from boats (Fig. 3). On account of soft bottom, the spurs sink into it considerably. Generally speaking, the construction of spurs is expensive and their ultimate value is not yet known.

In the near future will begin the construction of the Milsk Steppe irrigation project, by which 405,000 acres of land lying on the left bank of Arrax will be reclaimed. This means that altogether 870,000 acres will receive their supply from the Arrax River. It is hardly possible to supply this area, without the additional storage of water, from a river with a total annual runoff of about 5,165,000 acre-ft. The storage reservoirs and the supply of main canals are the chief problems of the future on the Arrax River.

The chief engineer, and the man who has been connected since the beginning with the irrigation works in the Mugan Steppe, is N. Petroff.

Annual Street-Cleaning Exhibition—Encouraged by the success which attended the exhibition of Nov. 23-28, 1914, and by the generally expressed desire for its repetition, the New York City Department of Street Cleaning announces that it will hold its second annual exhibition of street-cleaning apparatus and appliances in the First Regiment Field Artillery Armory, 68th St. and Broadway, New York City, during the week beginning Monday, Oct. 11, 1915. The exhibition of 1914 was more or less experimental. However, its results made manifest beyond all doubt the newly awakened and constantly increasing interest of the people in the vital question of public cleanliness. It also made clear the desire of public officials to improve their methods, as well as the alertness of the inventors and manufacturers who are striving to meet the demand for improved mechanical equipment. At the time of this year's exhibition it is expected the Model District, for which a special fund was provided by the Board of Estimate and Apportionment, and which is to be equipped with modern apparatus, will be well under way. The Model District should prove an attraction to manufacturers and inventors, as well as to visting officials. The street-cleaning apparatus eligible for entry in the forthcoming exhibition includes all sorts of brooms, brushes, sweeping machines, flushing machines and other equipment or applicances used in cleaning streets and removing snow; carts, wagons, motor trucks or other vehicles used for collecting garbage, ashes, rubbish and street sweepings; conveyances for transporting refuse, by water or by rail; methods for the disposal of garbage, ashes, rubbish and street sweepings, including garbage-reduction works, garbage crematories, incinerators, destructors, etc. Exhibitors will not be required to pay entrance fees. Legitimate street-cleaning apparatus and appurtenances will be given free space in the exhibition hall. Other costs of placing their exhibits and all risks must, however, be borne by the exhibitors, except that storage will be provided, without charge, for pieces of apparatus which arrive in the city of New York prior to the evening of Oct. 9.

Rebuilding the Muskingum Bridge Near Coshocton

SYNOPSIS—A three-span bridge weighing 3500 tons had to be slid into place laterally as a unit; the work had to be done between trains. Thoroughly planned moving arrangements enabled the moving to be completed in 10 min. 17 sec. from train to train.

During the last season two remarkable bridge-moving enterprises were carried out, involving in both cases the handling of very heavy riveted truss spans. In one case, the renewal of the Muskingum River bridge, a set of three double-track riveted truss spans was moved as a unit, yet in spite of this a record of quick and successful moving was achieved. In the other case, the Brunot's Island portion of the Ohio Connecting Ry. bridge over the Ohio River, eleven successive spans were moved, one by one, under railway traffic that was probably as heavy as that over any other large bridge in the country, and throughout the entire season's work this fact had to be dealt with. A further interesting fact is that both enterprises took place on the same railway and were carried out by the same contractors. They will be described in this and succeeding articles.

Conditions at the Muskingum River Crossing

At Tyndall, near Coshocton, Ohio, the "Pan Handle," or the Southwest System of the Pennsylvania Lines, crosses the Muskingum River by a double-track through riveted truss bridge about 735 ft. long. In the great flood of March, 1913, two piers were undermined and two spans carried away, one of the remaining spans being dropped at one end. The railroad was cut in two and remained so for nearly three weeks. Temporary repair was made by jacking up the dropped end of the second span on a crib and substituting for the two missing spans a temporary trestle, later replaced by a series of 70-ft. plate-girder spans carried on pile piers. Almost immediately permanent rebuilding was taken in hand.

Choice of Reconstruction Method

The character of the new foundations and the erection problem were largely the determining elements of the replacement. The bridge had to be built on the old alignment, but the replacement of the steelwork *under traffic* was believed to be practically out of the question, on account of the many interferences offered by the temporary structure, the very heavy and important train

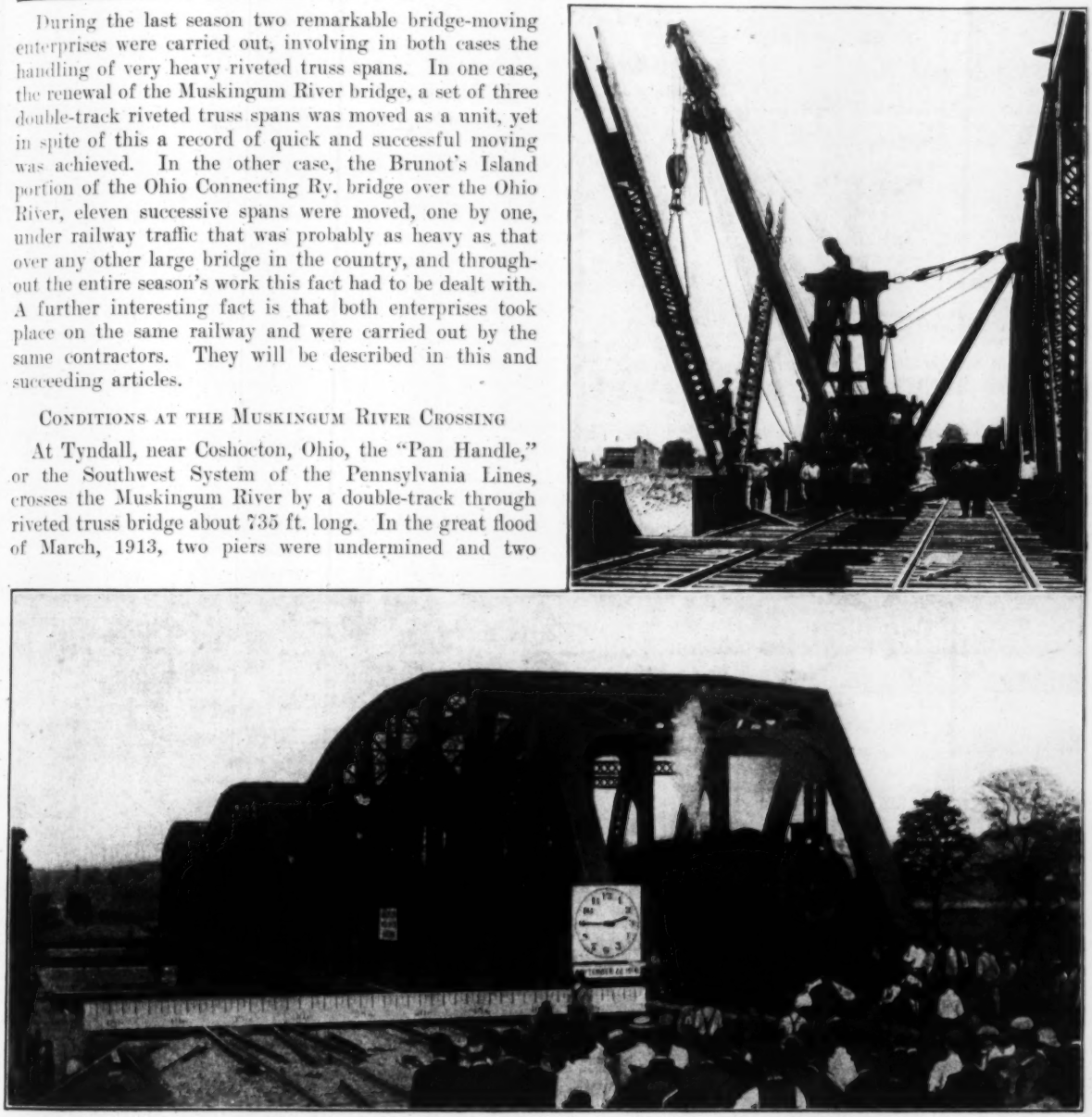


FIG. 1. NEW COSHOCTON BRIDGE DURING ERECTION AND AT START OF MOVING

movement over the bridge, the large amount of miscellaneous débris in the river at the site, and the treacherous nature of the stream itself. At the same time, the railway officials did not wish to operate over a temporary run-around trestle, as the traffic was too important and too fast and heavy to make this method prudent. It was therefore decided to build the new bridge on temporary supports alongside of the existing structure, and later on roll the new bridge over into its permanent position.

The problem was affected by two unusual factors—the necessity for building new piers and the consequent advantage of choosing new pier locations, and the fact that one half of the old bridge consisted of miscellaneous short spans put in to replace the two spans which had been washed out, while the other half consisted of the original spans, one of which was supported on cribbing and

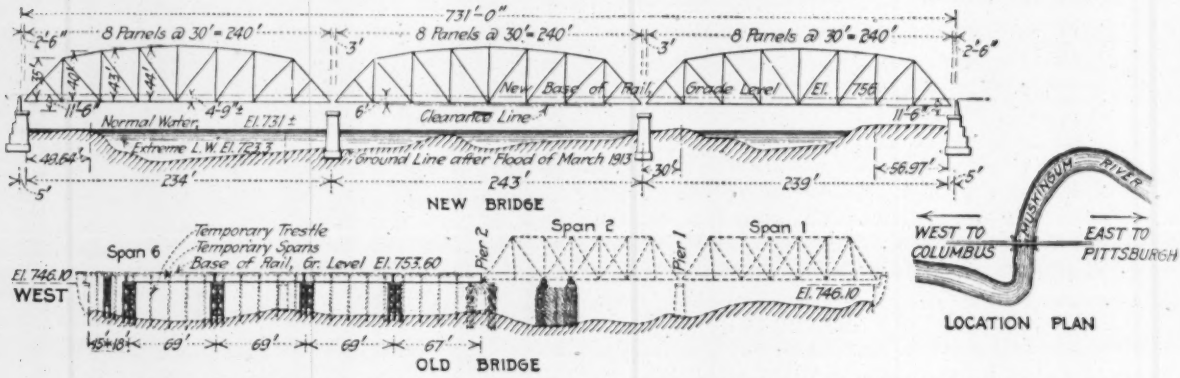


FIG. 2. NEW AND OLD BRIDGES ACROSS THE MUSKINGUM RIVER NEAR COSHOCTON, OHIO

The old bridge as shown involves three elements: Two truss spans, not torn out by the 1913 flood, single-track pile trestle built in place of two washed-out spans as first repair, and plate-girder bridge on timber piers as second repair. The plate-girder bridge only is shown by full lines.

protection. The 1913 flood underscoured one pier about 20 ft. below the bottom and destroyed it, while it tipped over the next one. Deep pneumatic-caisson foundations, resting in fine gravel, were therefore chosen for the new bridge. By a revision of the span lengths, substituting

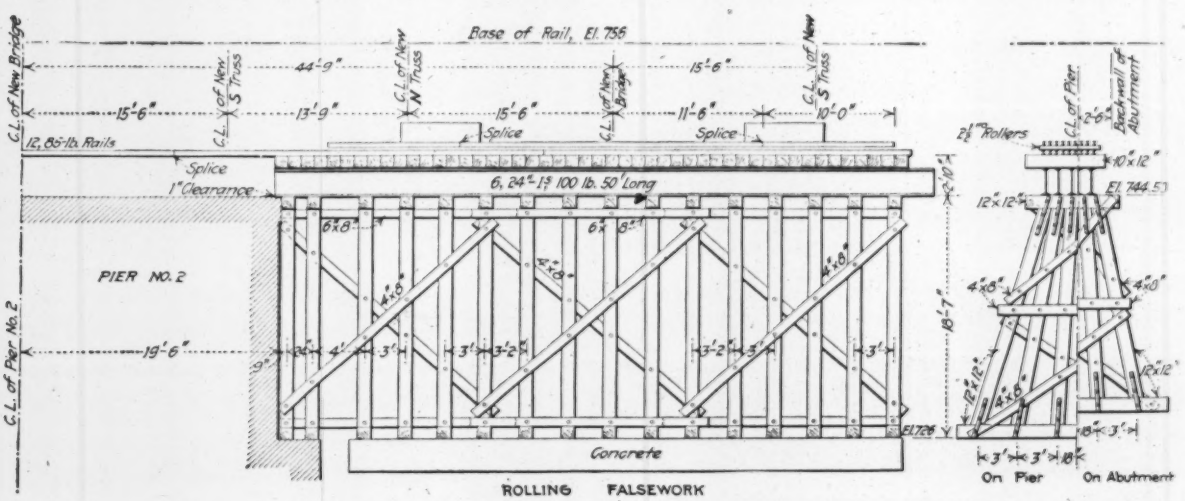


FIG. 3. ERECTION FALSEWORK AND ROLLING FALSEWORK, COSHOCTON BRIDGE

falsework that had been thrown in in a hurry in order to get the line opened as soon as possible after the flood.

Under these conditions replacement by rolling the separate spans into place in successive operations was impracticable; instead, it was necessary to roll the three spans of the new bridge, as a whole, in one operation.

Under this method it was preferable to tear out the old bridge before moving the new one, on account of the many interferences that would have been encountered, and on account of the character of the old and temporary structure, supporting cribs, débris, etc. To make this possible, traffic had to be carried over the new bridge in its temporary location while tearing out the old bridge, and the traffic over the line demanded that the break in the tracks while moving the bridge should be reduced to the shortest possible length of time. How this was accomplished in detail is described in the following.

The old piers, which were built a number of years ago, when the Pan Handle Line was originally constructed, were founded practically at the river bottom, with riprap

three 240-ft. spans for the four 155-ft. spans in the old bridge, the location of the new piers and abutments came clear of the old, so that they could be built complete without disturbing the old bridge to any considerable extent. The new piers and abutments were square, while the old ones were on a 15° skew.

After the new abutments and river piers were built, temporary piers for the erection of the new bridge were built in line with them, on the downstream side, where

they would be sheltered from drift and scour in case of flood. Because these temporary supports were to carry the regular traffic over the new bridge for probably two months while the old structure was being removed, and because of the very heavy loads carried (in the case of the two intermediate piers over 4,500,000 lb. per pier), more robust construction than ordinary pile bents was necessary. Both of the temporary abutments and one of the piers happened to come on ground that was dry at low water, and in these cases the temporary foundations were prepared by placing concrete mats about 5 ft. thick just below the ground surface. The remaining pier, however, came directly in the channel, in 20 ft. or more of water, and required some other form of construction. A novel type of pier was used, at the suggestion of S. P. Mitchell, consisting of a pile group filled around with sand retained by a timber box, and the whole capped with concrete, all as described in *Engineering News* of May 6, 1915, p. 890.

On the foundations thus prepared framed timber bents were placed, carrying 24-in. I-beams, which in turn supported the rolling ways and the dead- and live-loads of the bridge. These are shown in Fig. 3 as "Rolling Falsework."

Erection Trestle

For the erection of the new bridge, bents consisting of 12 piles each, capped and braced, were driven at each panel-point, that is, about 30 ft. apart. Fig. 3 shows their construction. To drive these bents a special cantilever piledriver was built, which could reach forward from the bent last driven, and in one setting drive six piles of the half-bent (described in *Engineering News* of Jan. 7, 1915, p. 28). The trestle, in fact, was built as two parallel trestles (one for each truss) connected by splices between their caps and sash timbers. The driver first drove and completed the 6-pile bents for one of the half-trestles for the full length of a span, setting the caps, bracing and stringers as it proceeded, and then returned and drove the other half-trestle.

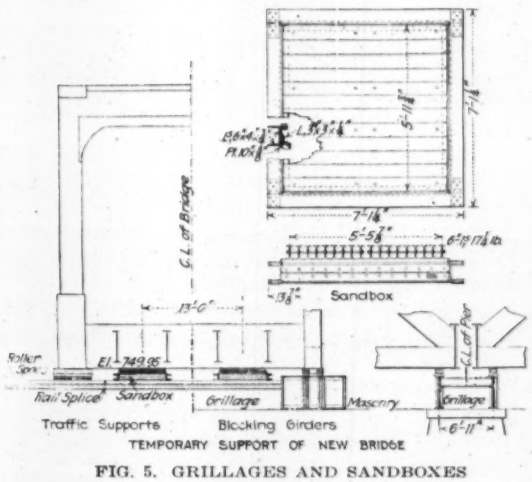


FIG. 5. GRILLAGES AND SANDBOXES

This erection trestle was in service only up to the time of swinging the new steel spans. Upon completing the steelwork the whole load of the spans was transferred to the "rolling falsework," and the intermediate erection bents were then removed. On account of the extremely heavy dead- and live-loads to be carried by the temporary abutments and piers, it was necessary to distribute these loads over the entire length of the temporary abutments and piers, instead of concentrating them under the truss bearing-points. This was accomplished by utilizing the end floor-beams of the spans (which were strong enough for the purpose) by the following method:

Sandboxes capable of carrying the entire dead-load were placed between the end floor-beams and the rolling ways,

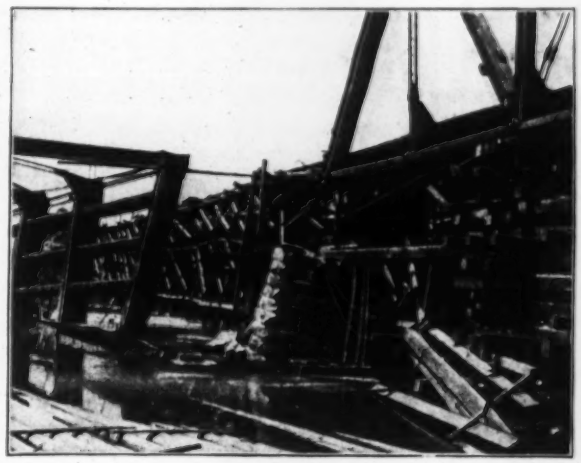


FIG. 4. CONDITIONS AT OLD COSHOCTON BRIDGE
Showing difficulties which complicated the erection

while the live-loads were carried by temporary grillages, consisting of two layers of I-beams with a layer of timber between, which were inserted between the rolling ways and the truss bearing-points.

In order to make sure that the dead-loads would be carried entirely by the sandboxes, the temporary blocking under the ends of the truss was removed before the blocking over the intermediate bents was taken out, and *the spans were swung on the sandboxes for supports.* The temporary grillages were then placed under the truss

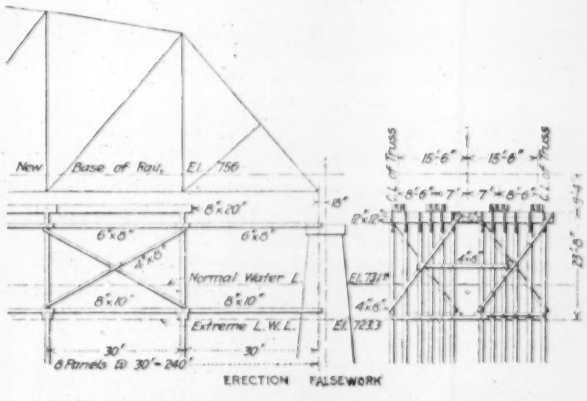


FIG. 6. VIEWS OF ERECTION FALSEWORK

bearing-points, and the layer of timber in these grillages driven in to a tight fit.

The primary purpose of the sandboxes was to hold the entire dead-load of the bridge a little above its permanent elevation, so as to permit the removal of the temporary

grillages and rolling ways and the placing of the shoes after the bridge had been moved to its final position and for lowering the spans to a bearing on these shoes, thus avoiding all jacking for the purpose of removing rolling ways, etc., and placing shoes, which, under the conditions, could have been done only with much difficulty and at considerable cost.

The grillages, rolling ways and sandboxes forming the supports for the new bridge in its movement from temporary to permanent position are shown by drawings in Fig. 5. The sandboxes are of unusual proportions, but otherwise follow the previous practice of the contracting company's engineer.

Traffic was turned over the new bridge as soon as its floor was completed and track laid, and the dismantling of the old structure was then proceeded with and preparations made for moving the new bridge over to its permanent position.

Moving the Bridge

The power for moving the bridge was obtained from the hoisting engines of two derrick-cars placed end to end in the middle of the center span. Four sets of 7-part wire-rope tackle were arranged to pull the spans along the rolling ways laid on the temporary and permanent piers, the four leadlines from these tackles being carried to separate drums on the hoisting engine (see Fig. 7). A vertical telltale, or indicator, set up directly in front of the position of the foreman in charge of the operation, was so arranged that four pointers traveled up the indicator as the corresponding bridge shoes moved along their tracks, thus making it easy to keep the four moving points exactly abreast of one another.

The moving was done on Sept. 22, 1914, and the railway officials, a large number of whom were present, had arranged, in order to make the progress of the moving more striking, a large clock dial at one end of the bridge, with a pointer on a horizontal scale alongside, so that the time and the progress of the moving could be readily seen. Within 10 min. 17 sec. after an express train passed off the west end of the bridge in its temporary position (see Fig. 1), a special train passed onto the east end of the bridge in its permanent position. During this interval the tracks were disconnected, the bridge (having a total length of about 735 ft. and weighing, including the derrick-cars, 3500 tons) was moved laterally a distance of 45 ft. and the tracks were then reconnected ready for regular traffic.

The remaining operations consisted of removing the rolling ways, etc., and the placing of the spans on their permanent shoes.

The splices in the rolling ways were so arranged that by splitting out the layer of timber in the temporary grillages these grillages, as well as the rolling ways under the truss bearing-points, could be removed without interfering with the rolling ways and sandboxes carrying the spans, thus making it possible to set the shoes under the truss bearing-points and lower the spans to their permanent position by means of the sandboxes.

The bridge shoes are carried by plate-girder grillages running the full length of the concrete piers and abutments and are attached to these grillages by large bolts. In order to avoid having to shift the spans longitudinally to make the holes in the shoes match those in the grillages, great care was taken to set the spans in their proper relation to the grillages longitudinally of the bridge and also to set the rolling ways exactly perpendicular to the center line, the result being that, after the bridge was moved laterally 45 ft., the holes matched so that the bolts could be put in with the greatest ease, thus showing that the bridge could not have shifted longitudinally during its movement more than about ⅛ in.

The entire work was carried out under the general direction of J. C. Bland, Engineer of Bridges, Pennsylvania Lines West of Pittsburgh, and the erection scheme and methods were devised by S. P. Mitchell, president of the Seaboard Construction Co., of Philadelphia, the contractor for the erection of the superstructure.

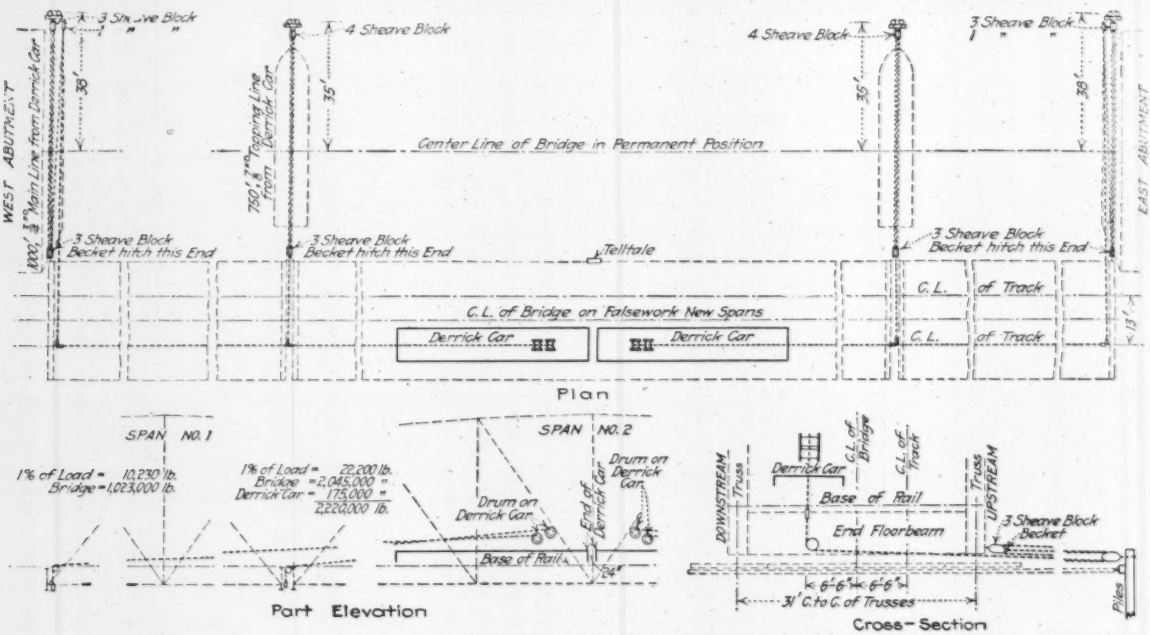


FIG. 7. ARRANGEMENT OF RIGGING FOR MOVING COSHOCTON BRIDGE

A New Form of Government Contract

By Richard D. Micou*

The specifications recently issued by the supervising architect of the Treasury Department for the construction of a new building for the Interior Department, Washington, D. C., mark the latest development in the endeavor of the supervising architect's office to devise a contract that shall make such provision for partial payments during the progress of the work as will be fair to the contractor, the subcontractor and the Government.

In this aim they have been much handicapped by the provisions of the Heard law, 28 Stat., 278, c. 280, which provides that persons entering into formal contracts with the United States for the construction of public buildings shall be required to furnish bond with the additional obligation that such contractors shall promptly make payments to all persons supplying them labor or materials in the prosecution of the work provided for in the contract, such persons being given the right to sue both the contractor and his sureties in the name of the United States.

This act has been interpreted by the United States Supreme Court in Hill vs. American Surety Company, 200 U. S., 197, to apply to any person who furnished labor or material in any particular, even as it has been said, to a man who cut down a tree from which planks were sawed that eventually went into a building. As a matter of fact, however, suits have rarely been filed by any one more remote from the contractor than the subcontractor of a subcontractor, and even such cases are extremely rare.

Up to about a year ago the specifications simply provided for the payment to the contractor each month of an amount covering 90% of the work completed during the month, as certified by the Government inspector; and such is the form of contract now in use for small contracts†. This was not in any way segregated, but was paid him in bulk and it was possible for a contractor to play one subcontractor against another from month to month, making it difficult for subcontractors to get their money. These payments to the contractor without any method of providing for partial payments to subcontractors and material-men as the work progresses frequently resulted in the surety being made liable for the contractor's obligations. In other cases the contractor would never quite finish the building, taking his own profit out of the 90% already paid him and leaving the retained 10% to cover unpaid claims for materials, etc., thus forcing the surety company not only to assume his obligations, but actually to finish the work in order to secure release on their bond.

During the past year, however, the supervising architect's office has been experimenting with the payment provisions of the contract, and the specifications for the present building represent perhaps the most nearly perfect form possible under the law.

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†Payment of 90% of the value of the work executed and satisfactorily in place, as ascertained by the supervising architect, acting through the superintendent, will be made monthly and payment of the 10% retained will be made after the final acceptance by the duly constituted representative of the Treasury Department, of all materials and workmanship embraced in the contract, but payment will not be made until every part of the work to the point for which payment is claimed is satisfactorily supplied and executed in every particular and all defects therein remedied to the satisfaction of the supervising architect.

The new requirements are in brief as follows: After the award of the contract, the contractor must furnish to the supervising architect a schedule of the cost of the main branches of the work, the sum total of which shall equal the amount of the contract. Upon the completion of this schedule the contractor must furnish a detailed supplementary schedule of the work and materials involved in each main branch, arranged as far as possible according to the various subcontracts and itemizing in detail the quantities of materials and labor involved, with the unit price for each (including overhead and miscellaneous expenses and profit).

A copy of these schedules is to be furnished to the government superintendent of construction; and on the fifteenth day of each month he certifies to the supervising architect an estimate showing the scheduled value of the work executed and satisfactorily in place and of the materials on the site but not in place. Upon such certification, the contractor is paid for 90% of the work executed and for 60% of the materials delivered and not placed. This last provision is an innovation and enables the contractor to receive pay for such materials as stone and structural steel to the extent of 60% several months before he would have received it under the old form of contract.

These payments are exactly subdivided and apportioned so that it is possible to tell at any given time what has been paid to the contractor for any part of the work or for any of the materials delivered. After having completed this estimate for a partial payment, the superintendent of construction prepares and posts on the bulletin board in his office a statement of the same for the information of subcontractors and material-men, showing in percentage the ratio of the total payments to date on account of each subcontract.

Before any subsequent payment can be made the contractor is compelled to submit to the superintendent of construction an affidavit setting forth that he has made payment to the subcontractors and material-men in the proportion shown to be due them by the previous statement; or, if he has failed to make such payment, to state how much has been withheld and for what reasons. His subsequent payments depend on this statement. The contractor may further be required to make a sworn statement before he is fully paid on the work to the effect that all subcontractors and material-men have been paid in full.

A further innovation of considerable benefit to the contractor is the provision that after gross payments aggregating one-half of the contract price have been made, the supervising architect may remit to the contractor one-half of the percentage retained on the first quarter of the work; after gross payments aggregating three-quarters, one-half of the percentage retained on the second quarter; and after the work is completed, awaiting final inspection, one-half of the percentage retained on the third quarter.

At the time of the final payment, therefore, the retained percentage would amount to 5% on the first three-quarters and 10% on the last quarter instead of 10% on the whole as formerly.

The provisions outlined above do not relieve the contractor or the surety of their obligations but they do prevent the indefinite postponement of partial payments to subcontractors and the accumulation of claims at the end of a contract.

Track Depression at Mattoon; Illinois Central R. R.

SYNOPSIS—Details of a grade-crossing elimination, involving cuts and special reinforced-concrete bridge crossings.

The elimination of grade crossings at Mattoon, Ill., has been complicated by the fact that two railways intersected near the center of the city. With a train standing at the station or a long freight train passing over one line and trains held on the other line, the street traffic was blocked to a serious extent. The plan adopted was to lower the Illinois Central R.R. (as having the heavier traffic) and to leave the Cleveland, Cincinnati, Chicago & St. Louis Ry. unaltered. At the intersection a two-story union station will be built, with station facilities on the first floor and railway offices above, stairs leading to the platforms of the depressed tracks.

The grade is lowered through the city for about 7000 ft., and continues for some distance beyond, to the freight yards. This eliminates a former summit with 0.6% grades and gives a slight sag, with descending grades of 0.3% from the south and 0.05% from the north. This effects a material improvement in the operation of the division. The maximum depth of cut is about 28 ft. The C., C., C. & St. L. Ry. will be raised about 2 ft. at its bridge over the cut, and five street bridges will be built. An inclined transfer track north of the station will provide for interchange between the two lines.

The Illinois Central R.R. has a 200-ft. right-of-way, and the cut is taken out to a bottom width of 100 ft., with nominal slopes of 1 on 1. This provides for five main tracks, with three through tracks and platforms at the station, and leaves room for a future additional track. At the south end of the station will be two stub tracks for the lines east to Evansville and west to Peoria. Originally, the Peoria & Evansville division had crossed the main line at grade, but this crossing has been replaced by double Y connections on each side, so that trains will not run through between Peoria and Evansville. For this division a new freighthouse and team yard have been built, as shown.

It was expected that the clay in which the cut is made would slip after the steam-shovel work and stand finally at about 1 on 1, so that retaining walls would not be neces-

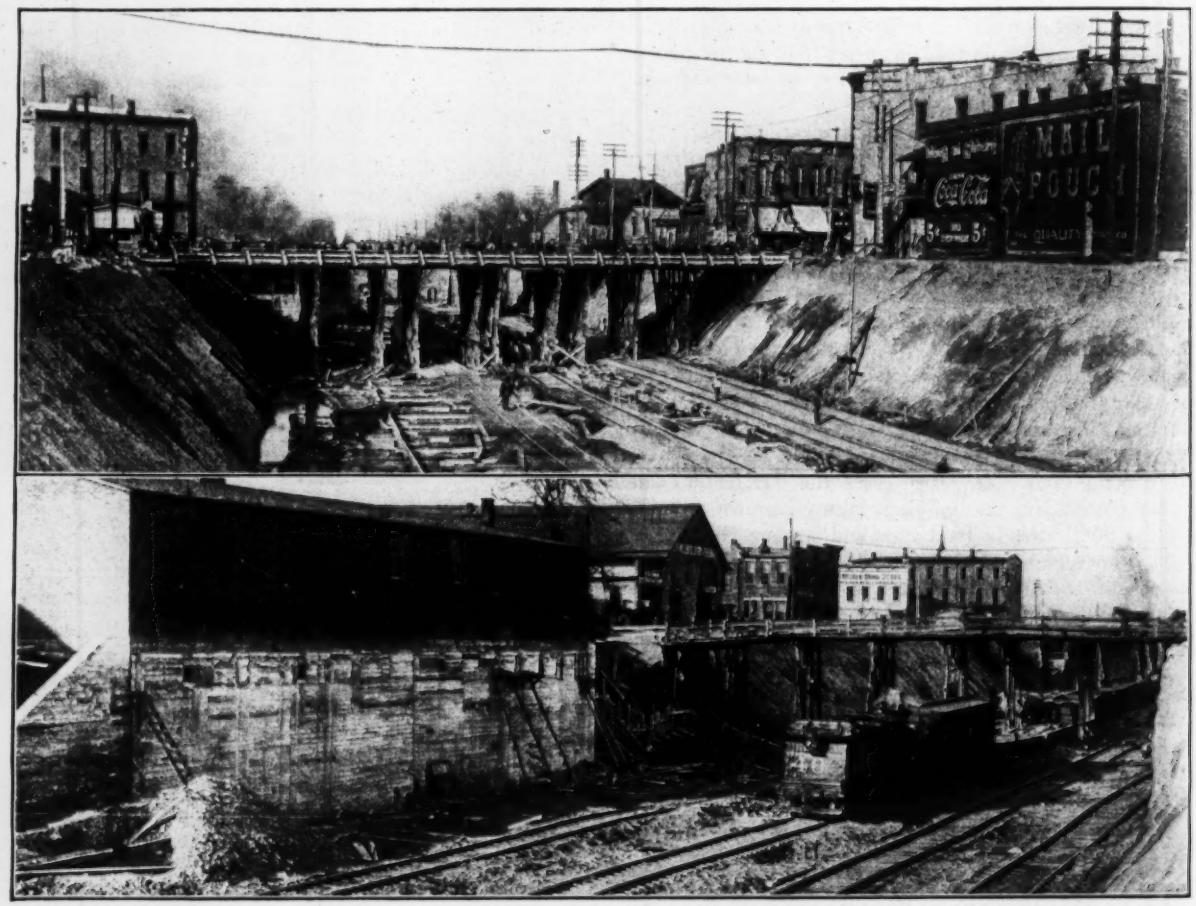

FIG. 1. TRACK DEPRESSION AT MATTOON, ILL.; ILLINOIS CENTRAL R.R.

The upper view shows the work at Broadway, with the temporary bridge. The new station will be at the left. The three-story building at the left is the old union station and hotel, a part of which has been pulled down to make room for the slope of the cut. The lower view shows a broom-corn warehouse, with concrete underpinning. Beyond it is the temporary bridge at Charleston St.

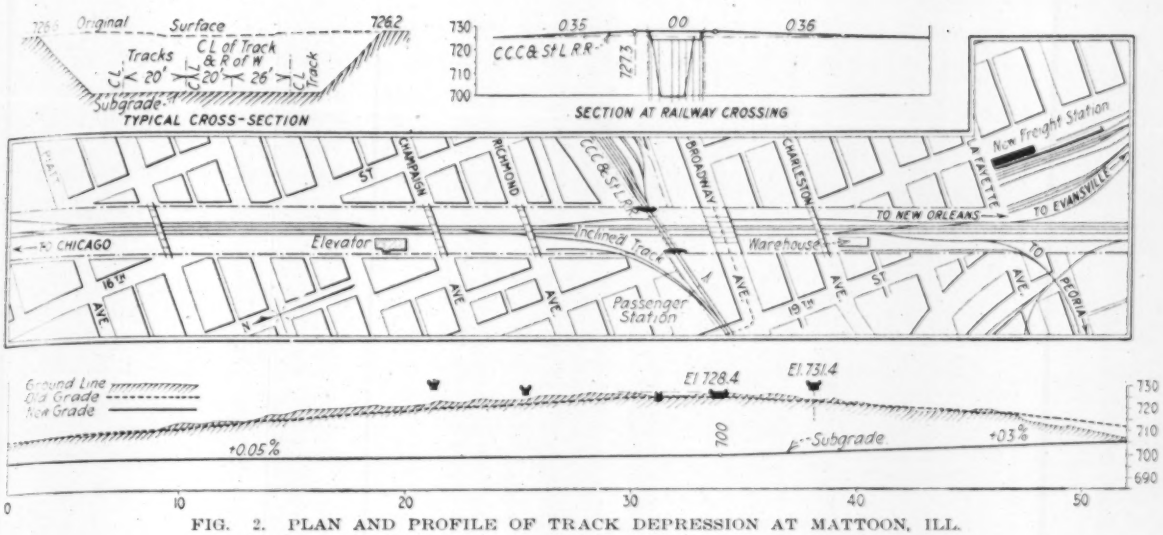

FIG. 2. PLAN AND PROFILE OF TRACK DEPRESSION AT MATTOON, ILL.

sary. But the material continues to slide and cave, and it is probable that retaining walls will have to be built in the deeper section, where the slips may affect private property. To keep the right-of-way clear, a toe wall of piles backed with heavy planks has been built, but this does not check the slipping.

There are several industries adjacent to the right-of-way line. In some cases the buildings occupied by these have been supported on timber trestling, allowing the slope to extend beneath them; in others a heavy retaining wall has been built. For this latter work piles were first driven and I-beam needle-beams placed with the inner ends resting on solid ground and the outer ends on the piles. A trench was then made to the required depth, and the retaining wall was built before making the cut for the track depression.

The typical design of the street bridges is shown in Fig. 3. There are five spans of 30-ft. clear width measured on the square, providing for four main tracks and for inclines to the industry connections. Most of them are 30 ft. wide between parapets, with 20-ft. roadways. But the bridge at Broadway, the principal street, will be 100 ft. wide, with 25-ft. sidewalks. The bridges are of reinforced concrete, with slab and beam deck supported on bents and abutments. No piling is required, the footings being carried down in the clay to about 5 ft. below subgrade. In the bents the columns are connected at the bottom by a guard wall 3½ ft. high above rail level, as a protection against derailed wheels. The beams of the floor slab rest on brackets upon the faces of the bents and abutments, and the sidewalks are cantilever slabs carried by brackets on the ends of the bents.

Gas and water mains are carried through the bents, being supported by U-hangers embedded in the deck slab. The sewerage system being separated by the deep cut an intercepting sewer had to be built along the east side of the right-of-way.

In concreting, the bents are poured to the level of the tops of the column shafts, and the concrete for the cap girder, extending to the top of the bent, is poured sepa-

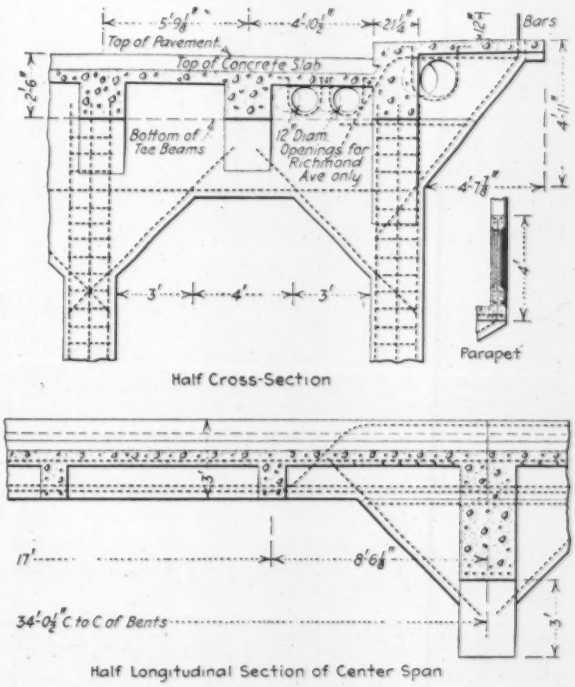

FIG. 4. DETAILS OF BRIDGE OVER TRACK

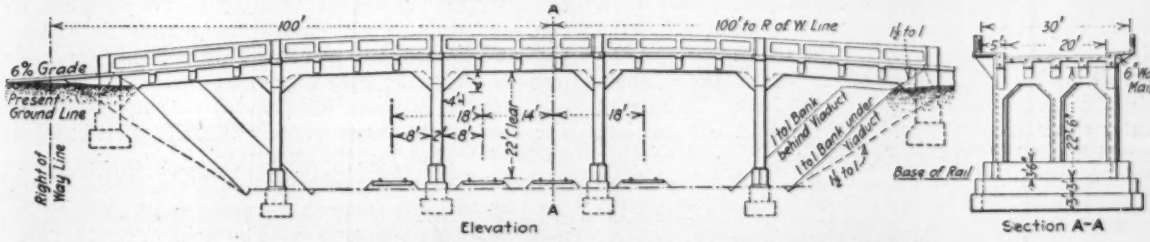

FIG. 3. TYPICAL DESIGN OF REINFORCED-CONCRETE BRIDGES

rately. The floor slab, with its longitudinal and transverse beams, is poured next, the parapets being poured last as a separate operation. The forms are of wood. The concrete in the footings is 1:3:6, and that in the upper work 1:2:4, using both gravel and broken stone. A concreting plant is installed adjacent to the bridge, with an elevator tower for spouting the concrete into place.

The C., C., C. & St. L. Ry. will be carried by a double-track through-girder bridge, the steel being incased in concrete to harmonize in appearance with the adjacent street bridges. This railway and the several streets are carried across the cut by timber bridges during the progress of the work.

In making the excavation a cut wide enough for two tracks was made first, while trains were operated on surface tracks at one side of the right-of-way. When running tracks were laid in the cut, the surface tracks were abandoned and the cut then widened to full section. In both cases two 75-ton steam-shovels were used, working from opposite ends of the work. The material was handled in 12-yd. side-dump cars and was all used for widening the roadbed and freight yards south to the city.

The cost of the work will be about $600,000. All of this will be paid by the Illinois Central R.R. and the C., C., C. & St. L. Ry. The grading was let to J. D. Lynch, of Monmouth, Ill., and the concreting was done by the Bates & Rogers Construction Co., of Chicago. The work was begun in April, 1914. The four-track cut was completed in December, 1914, and the bridges are rapidly nearing completion. The work is under the direction of A. S. Baldwin, Chief Engineer of the Illinois Central R.R., and F. L. Thompson, Assistant Chief Engineer.

Framing of the Dome of the Palace of Horticulture

By A. W. Earl* and Thos. F. Chace*

SYNOPSIS—Details of intricate steel work of a special dome. Method of erection also given.

The dome of the Palace of Horticulture at the Panama-Pacific Exposition, already referred to in *Engineering News* of Oct. 15, 1914, p. 759, is quite fully shown as to framing by the group of drawings in Fig. 1 of the present article, and is briefly described in the following.

Dome Framing

The dome framing is similar to that first used by the noted German engineer, Schwedler, being of the rib type. The dome has 24 latticed ribs, 36 in. in depth, which frame into a ring at the top and are connected by 11 horizontal latticed rings. These horizontal rings are 18 in. deep, except a 36-in. ring at the springing line of the dome, which absorbs all residual dome thrust. The ribs, however, continue 25 ft. below the springing line as vertical members framing the cylindrical base of the dome, down to a level 65 ft. above ground, where they foot upon a system of girders forming the top of the supporting tower.

Between the main ribs, 4-in. I-beam jackrafters frame into the horizontal rings. These carry wooden purlins to which skylight bars are attached, all of the dome surface except the basket being glass. All bays of the dome frame are braced by crossed adjustable rod diagonals, ranging in size from $\frac{9}{16}$ in. square at the top to $1\frac{3}{8}$ in. square at the bottom.

In all the latticed members of the dome framing, angle lacing bars were used instead of flat bars. These give greater shear resistance and can transmit compression, for which flat bars are poorly adapted.

The spider or ring at the apex of the dome is a circular girder 6 ft. in diameter and 36 in. deep; it has $\frac{5}{16}$-in. web-plate and four flange angles 4x4x$\frac{5}{16}$ in. Two diametral diaphragms at right angles to each other stiffen the ring. These have 3x3x$\frac{5}{16}$-in. flange angles, and $\frac{5}{16}$-in. web-plates.

Supporting Tower

The system of tower framing supporting the dome itself is also shown in the drawings, Fig. 1. It comprises eight piers capped by girders and trusses. Each pier is composed of four columns placed at the corners of a trapezoid. The trapezoid has two sides normal to a radius of the dome passing through its center, the shorter side being 4½ ft. long; the diverging sides, which inclose an angle of 45 deg., are 15 ft. 10 in. in length. The outer and inner sides of the piers are braced from bottom to top, but the diverging sides have portal-framed openings for a height of 14 ft. 7 in. from the bottom, to provide a passageway.

Between the tops of the interior columns of adjacent piers are plate-girders 6 ft. 4½ in. in depth, 57 ft. 5⅞ in. long. These, together with trusses which frame from girder to girder across the interior face of the piers, support the 24 ribs of the dome.

Between the exterior columns of adjacent piers, steel trusses (also 6 ft. 4½ in. deep) support a portion of the flat roof and the staff ornaments forming the decoration of the wall surrounding the lower part of the dome. These trusses, as well as the plate-girders on the inner face of the tower, are kneebraced to the columns of the piers. The trusses and plate-girders are braced together in both upper- and lower-chord planes. This not only serves the purpose of bracing the compression chords of the girders and trusses, but constitutes a stiff ring around the entire base of the dome which effectually distributes the horizontal wind load to all of the eight piers.

Each of the inner columns is a 20-in. 59-lb. I-beam; the two adjacent columns are laced together front and back with 5x3x$\frac{5}{16}$-in. angles. The lacing is doubled above the knee-braces, to provide for portal action. These col-

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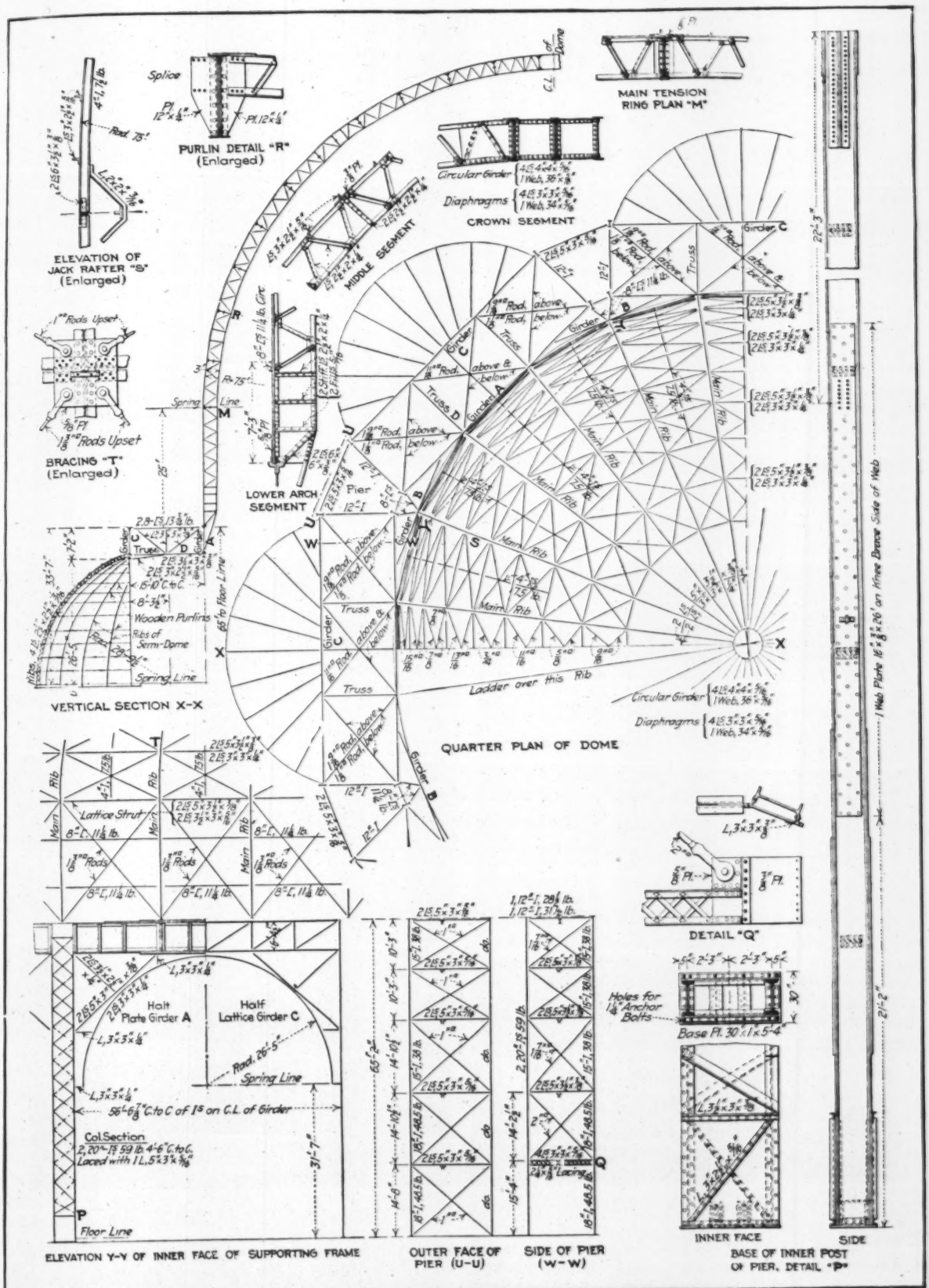

FIG. 1. FRAMING OF DOME AND SUPPORTING TOWER, PALACE OF HORTICULTURE, PANAMA-PACIFIC EXPOSITION, SAN FRANCISCO

umns are reinforced by flange-plates and by web side-plates in the respective regions of maximum bending, as indicated in the drawing of these columns in Fig. 1. The outer columns of the pier are each one I-beam, 15-in. 38-lb. in the upper section, and 18-in. 48½-lb. in the lower section.

Particulars as to makeup of trusses and bracing are given in the drawing.

The weight of steel for that portion of the structure above the tower plate-girders is 200 tons. This amounts to 8½ lb. per superficial sq.ft. of roof surface, or 0.304 lb. per cu.ft. of volume of the portion considered. The total weight of steel in dome and substructure is 503 tons, giving an average weight of 0.358 lb. per cu.ft. volume inclosed by the frame. The corresponding quantities for the dome of the Horticultural Building at the Chi... Exposition, as computed from the data in the artic... in *Engineering News*, March 12, 1892, p. 240, were: St... per sq.ft. roof, 10.7 lb.; steel per cu.ft. inclosed sp... 0.312 lb.

Erection

The steel of the supporting frame of the dome re... upon a timber grillage supported by piles. The timb... caps are well drift-bolted to the piles. This is count...

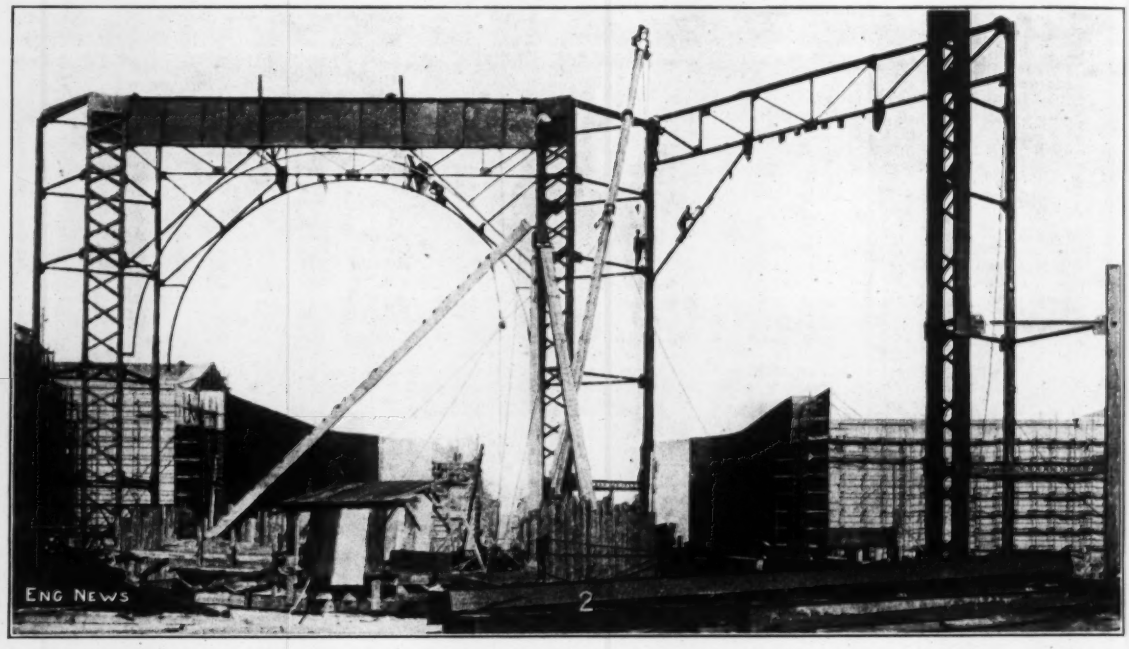

FIG. 2. ONE SIDE OF SUPPORTING TOWER OF DOME COMPLETED, AND ANOTHER SIDE BEING ERECTED

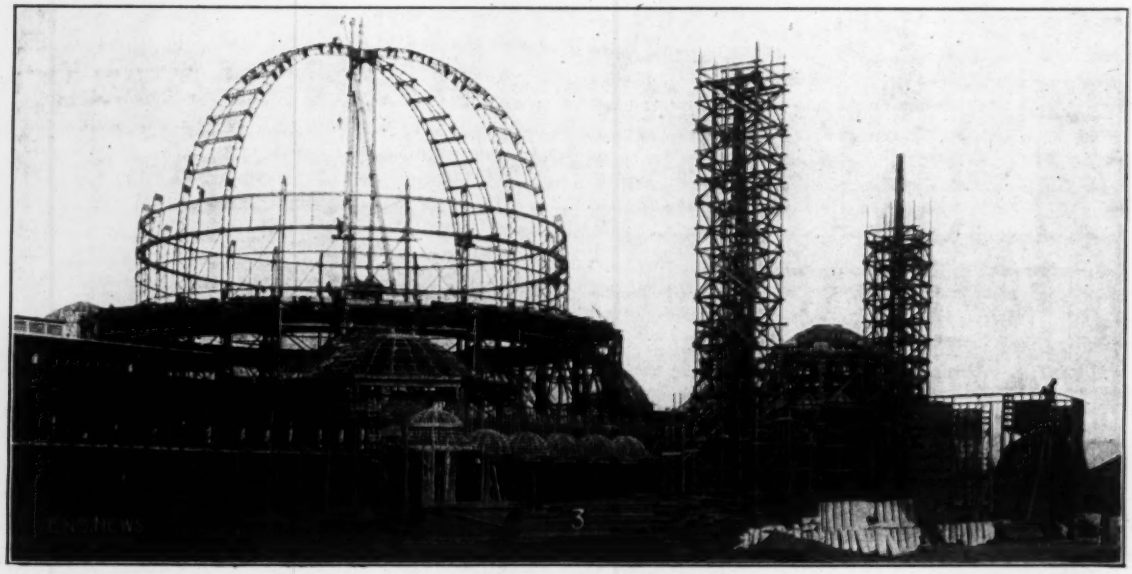

FIG. 3. PLACING UPPER RIB SECTIONS OF DOME; LOWER PART OF DOME ALREADY ERECTED

on as producing some fixing effect upon the column, which was utilized in the analysis of stresses.

The supporting frame up to the base of the dome ribs was erected complete before any of the ribs were placed. For raising the ribs, a battered tower was constructed in

the center of the dome area, in height slightly greater than the top of the dome substructure. Upon this tower were placed one guyed mast and two guy derricks. The mast supported the top ring of the dome by means of rod hangers with turnbuckles; adjustment of the top ring to position was made by means of these turnbuckles and similar turnbuckles in the mast guys.

The portion of the ribs between the girders and the first splice, including the rings and diagonal rods, was erected first. Meanwhile the remaining ribs were assembled in pairs on the ground, a pair of ribs with the connecting rings and diagonal rods being riveted together, and swung into place by the guy derricks, completing the erection of the steel. The weight of a pair of rib sections, completely assembled, was approximately 8 tons.

All steel connections of the dome frame itself were riveted; the supporting frame, however, has bolted steel connections, ordinary bolts being used.

The plans for this building were prepared by the Division of Works of the Exposition Company. H. D. H. Connick is Director of Works, and A. H. Markwart is Assistant Director of Works. The dome and substructure were designed by the writers under the immediate supervision of H. D. Dewell, Chief Structural Engineer. After the design was completed, the stresses in the dome were checked by R. G. Doerfling, Civil Engineer.

Bakewell & Brown, of San Francisco, were the architects of the building. Dyer Bros., of San Francisco, were the contractors for the fabrication and erection of the steel.

A Proposed Rating System for Track Scales

By A. M. Van Auken*

There is no well-defined manner of determining the capacity of either a track scale or a wagon scale. Most scale companies calculate the scale for a distributed load and call that its capacity, although some have in certain instances just doubled this. Many railway engineers who have studied the scale question are of the opinion that the capacity of the scale should be twice the load which can be imposed upon one section, while a few think it should be 2½ times this.

To illustrate the wide divergence thus created between the scale designer, the scale salesman and the railroad engineer, a well-known four-section scale of the cross-lever or Fairbanks type may be cited. It was designed for a distributed load of 330,000 lb. and called by its designer a 150-ton scale. The salesmen for the company call it a 300-ton scale, while those engineers who consider twice the weight on one pair of levers as the capacity would call it a 110-ton scale and those who would allow 2½ times the weight on one pair of levers to be the capacity would call it a 137½-ton scale.

There are three parts to a track scale—scale-pit and foundation, weighing machine, or scale proper, and weigh-bridge and its tracks. The deck over the pit is part of that structure. At certain points the weighing machine rests on the foundation, while at points above it supports the weigh-bridge. The scale is called a four-section scale when there are eight such points and a five-section when there are ten, there being a set of two cross-levers at each point. Each cross-lever transmits the load to a longitudinal lever, and other levers transmit it to the weigh-beam. The capacity of the scale is not affected by the scale-pit or weigh-bridge, though each of these must be adequate to the service it must perform. The accuracy of the scale depends upon the sufficiency of the levers in strength and rigidity and upon the sufficiency in length and perfection of bearing of the pivot—or, as it is commonly called, the knife-edge. As the levers are made of cast-iron, of steel castings and of rolled steel sections, there is a wide range in their rigidity and ultimate strength. Another feature of the capacity is the weigh-beam, which must be graduated to a point where it will weigh the maximum load to come upon the scale.

It is proposed to suggest a better method of designating scales than the present one of capacity.

A suggestion has been made by W. Samaus, of the Bessemer & Lake Erie R.R., for describing a scale—namely, to use three sets of figures. Scales are installed in several ways: (1) With weigh-bridge and scale-rail the full length of the pit; (2) with ends of the pit bridged over so that the end of the scale-rail comes just over the center of the end levers and pivot; (3) with ends bridged so that the end of scale-rail comes at some point between the first and second pair of levers and pivot. Each will call for a different length of scale-irons and pit for the same scale-rail. Mr. Samaus suggests calling a scale by figures which will represent (a) length between centers of end sections of scale, (b) number of sections of scale, (c) length of scale rail. Thus, a scale 52 ft. between end sections, with four sections, and 50-ft. scale-rail, would be denominated a 52-4-50 scale. This seems a most excellent suggestion.

Another compound expression which would give a good description of the scale might be used. Let the first figure give in thousands of pounds the load for which the main lever is designed, the second the length in inches of the bearing of the main knife-edge or pivot, and the third the capacity of the weigh-beam in thousands of pounds. Thus the well-known "B. & O." scale would be described with reference to capacity as 55-10-200 and the New York Central Lines West proposed scale as 75-15-300; in each case the correct capacity of the scale would be indicated. As to how the capacity of the lever should be rated, it might be well to define that it should be able, in a testing machine, to sustain the load named without showing a deflection in excess of one two-thousandth part its length, and to sustain double that load without permanent set, leaving choice of metal to the builder.

This plan is offered as a step forward and in the hope that it or some better method will be adopted which shall correct the prevailing confusion. Even in cases where scales are designed for a stated load under present conditions it is possible for a "150-ton" scale to have its levers designed for a static load anywhere from 50,000 to 75,000 lb. and its main pivot to be anywhere from 5 in. to 15 in. in length. Some scale men contend for a load of 10,000 lb. per lin.in. of pivot, while others would not allow over half that amount.

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The First Honorary Doctor's Degree in Engineering to be awarded in this country, so far as we can determine, was that given by New York University in June, 1866, to Erastus W. Smith, who became Doctor of Physical Science, "in recognition of his abilities as an engineer."

Engineering Literature

A New Railroad Field Book

REVIEWED BY M. P. PARET*

RAILROAD FIELD MANUAL FOR CIVIL ENGINEERS—By William G. Raymond, M. Am. Soc. C. E., Professor of Civil Engineering and Dean of the College of Applied Science in the State University of Iowa. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Leather, 5x7 in.; pp. vii + 398; 31 text figures and 83 tables. $3, net.

The author has in his preface largely confined his remarks to his suggested general adoption of the decimal division of degrees and of five-place tables. While the actual use of either is not new, yet a practical effort to make their use universal as good, or the best practice, is new, and the author is to be commended for his courage in coming to the front in a way tending to a practical realization of his hope for a general adoption of such features.

The engineering profession is not so hidebound by precedent as is that of the law, but, like the "man from Missouri," it likes to be "shown." Its conservatism requires practical demonstration of applicability before it will adopt anything new as good practice.

This is an age of overtalked, overwritten, but underapplied, efficiency. The general (it should be the universal) adoption and use of the author's tables will be a deserved example of applied efficiency.

The feature of having the applicable tables assembled with the immediate subject matter is practical and commendable; however, a thumb index would materially assist to locate them quickly.

It seems to be a more or less firmly established principle that a review of a book must be largely a criticism. It would be unjust to Professor Raymond to utilize more space in criticism than in commendation, without first stating that the commendable features are largely in excess and at the same time apparent.

The treatise is a "Railroad Field Manual," and when considered by the man behind the gun—the field man—it is found to lack certain features which, if not essential, may safely be termed desirable, as tending from a practical point of view to completeness.

There are noticeably two features, or, more properly, classes, of railroad field work which might have been profitably mentioned but which are not—railroad surveys and railroad valuation. Railroad surveys—reconnaissance, preliminary and location—are the very foundation of railroad work, and upon the outcome of these is very largely dependent the final success of the railroad. The omission of a chapter on railroad surveys materially reduces the value of the treatise as a field book. Railroad work does not begin with the running of curves, the use of the spiral or the application of "location theories and tables" and "estimating and construction tables."

In a chapter on railroad surveys there might be presented a brief practical method of determining a P. I., short cuts to setting angles on vernier for successive deflections, thumb rules and short practical methods generally.

Lavis' treatise on "Railroad Location Surveys," issued in 1906, while possibly not fully modern, is about the best compendium of good practice in that line, and a condensation of its subject matter would seem a very desirable, if indeed not an essential, feature of a railroad field manual.

Not so essential, but to be up to date, a brief chapter on railroad valuation would not have been out of place. Life is too short to cull something practical out of the great mass of what has been *written* on the subject of railroad valuation, but from what has been *done* by corporations and state commissions it would be feasible to compile a useful abstract of field practice.

In connection with the use of Table I, p. 12, and following the introduction, a table converting minutes into decimals of a degree would be serviceable. The table of tangential corrections on p. 33 might well have been extended to angles over 20 deg. to cover certain classes of interurban and street-railway and yard and canal work.

The chapter on "The Spiral" seems unnecessarily voluminous, both as to text and tables, although it might have been well also to give an illustrative example of spiraling a simple curve. The form of spiral used is a good one, but the tables are not carried out far enough for use in mountain country calling for sharp curvature and short tangents. To illustrate: If there was a 10-deg. curve and the tangent length between curves were limited to 40 ft., the amount available for that curve spiral (Table XXIII, for shortest spirals) would give 49.92 ft. for "L," necessitating a rather complicated use of the tables.

Chapter V should have embraced an article on overhaul. While the tendency may be toward pay-both-way contracts, yet there are many railroad companies which almost universally use haul-clause contracts, and there are many sections of country where to get desirable competitive bids and economic grading its use is necessary.

Table LXI, p. 290, is ostensibly for the conversion of linear feet of 100-ft. wide right-of-way into acres. In point of fact it is a table to convert acres into linear feet of 100-ft. wide right-of-way. If it were what the text terms it, the first columns should contain "linear feet of R. O. W.," and the second "acres;" then, with the first column reading by tens, the table would have covered the ground in less space and in a more practical manner for field application.

The chapter on "Turnouts and Crossovers" deals only with straight track. It might well have contained something on turnouts from the inside or outside of curves.

I take this opportunity to express to my assistants, H. J. Saunders, G. T. Morris and R. T. Guppy, my appreciation of valuable comments on this book from the viewpoint of modern field practice.

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Electric Railway Handbook

ELECTRIC RAILWAY HANDBOOK: A Reference Book of Practice Data, Formulas and Tables for the Use of Operators, Engineers and Students—By Albert S. Richey, Fellow, Am. Inst. E. E., Consulting Engineer, Professor of Electric Railway Engineering, Worcester Polytechnic Institute; Assisted by William C. Greenough. New York and London: McGraw-Hill Book Co., Inc. Flexible leather; 6x7 in.; pp. xi + 832; illustrated. $4, net.

Most engineer-authors would have felt that the subdivision of engineering work on an electric railway was so distinct that there would always be track and structure engineers, electrical and mechanical men, etc., and that a general handbook of electric-railway engineering would not be demanded. But Professor Richey enjoys a large acquaintance among street-railway engineers and has a good chance to find the need for such a book, as well as what should go into it. The book certainly brings together in very convenient form a variety of data which have been widely scattered before.

Location and the cost of the various operations of original construction appear first. Standard city-track construction on a number of important systems is pictured and the use of various standard and special rails is discussed. Theory and practice in track work are briefly outlined, including diagrams of some notable car-barn track layouts. Considerable attention is paid to general car-house and shop layouts.

Following this is a section on train movements—building up schedules and finding train resistance, acceleration, run curves, current requirements, etc. A section on motors gives typical characteristics, selection for a given service, methods of maintenance and repair, and lubrication practice. Another section describes the available systems of motor control and gives a few notes on inspection and maintenance. Many data on practice throughout the country are given in the sections on trolley wheels and other collectors, and on trucks, axles, bearings and wheels.

One section takes up braking, going into such ultimate details as variations of friction coefficients, weight transfer, relations between air pressure, piston areas, and lever lengths, shoe positions, rigging standards, slack adjusters etc. Various air-brake systems are described at length. Other types of brakes (besides hand brakes), such as magnetic, reversed-motor, regenerative, etc., are briefly noted. The growing importance of regenerative braking, as manifested by recent important heavy installations, would have excused a more detailed presentation of that topic than is found under train movements or brakes.

Rolling stock is given one section, diagrams for a large number of urban surface and rapid-transit and interurban cars being shown. The advantages and limitations of surface-car trains are presented. Practice in cleaning, heating, ventilation and lighting of cars is reviewed. The most important features of the leading types of electric locomotives are presented in a form making comparisons easy.

Under transmission and distribution are grouped important details of trolley-wire supports, data for steel, concrete and wood poles, specifications for overhead crossings of light and power lines, features of approved wires and cables, etc. Third rails and conduits are not neglected. The importance today of the return circuits warrants the attention here shown to details of track bonding, electrolysis of neighboring buried structures, insulated negative feeders, etc. Some will feel that this section could have been strengthened by giving the electrolysis-mitigation results secured in various cities with the coöperation of the Bureau of Standards.

The final pages of the book give brief summaries of commercial processes for preserving wood and descriptions of various signal and telephone lines, highway-crossing warnings, etc.

Automatic Telephones

AUTOMATIC TELEPHONY: A Comprehensive Treatise on Automatic and Semi-Automatic Systems—By Arthur Bessey Smith, M. Am. Inst. E. E.; Formerly Professor of Telephone Engineering, Purdue University, and Wilson Lee Campbell, Fellow Am. Inst. E. E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xii + 407; 271 illustrations. $4, net.

Engineers generally feel that ordinary telephony is a complicated art and science not to be seriously invaded except by specialists; and automatic systems are commonly regarded as still farther beyond ordinary comprehension. The several good treatises on manual systems have done much to open up that branch to any intelligent student, and this book will do the same for the other division. The automatic equipment and operation is, of course, extremely complex, but it can be mastered if studied step by step with a lucid text like this.

The authors have succeeded, as well as could be expected in 400-odd pages, in describing typical apparatus and circuits of the more important makers, including the Western Electric Co. (the manufacturing department of the American Bell system). Their more general discussions, however, on territorial development, traffic, central-station design, long-distance lines, etc., have followed the practice of a single company—the Automatic Electric Co., probably the best known of the "independent" makers of automatic-telephone equipment.

The volume opens up with a discussion of "trunking"—economic arrangement of leads from subscribers to the central office. After this it plunges into the details of calling and switching systems, which make up the book, except for the general discussions noted before.

Line-Wire Sags and Stresses

GRAPHICAL DETERMINATION OF SAGS AND STRESSES FOR OVERHEAD LINE CONSTRUCTION—By Guido Semenza, Local Honorary Secretary of Am. Inst. E. E. for Italy; Consulting Engineer and Technical Adviser of Societa Edison of Milan, and Marco Semenza, Electrical Engineer, Milan. Translated from the Italian by C. O. Mailloux, Past-President, Am. Inst. E. E., Consulting Electrical Engineer. New York and London: McGraw-Hill Book Co., Inc. Cloth; 9x12 in.; pp. x + 24; 13 charts. $3, net.

Essentially this volume is a collection of diagrams from which anyone, knowing the diameter of copper distribution- and transmission-line conductors, the minimum allowable stress, the length of span, minimum temperature, wind velocity, and thickness of probable ice coating, can find the sag which should be given at the temperature prevailing when the wire is strung. Besides the working charts themselves, there are sections showing their derivation and giving practical examples of their use.

The authors are distinguished Italian engineers and pioneers in foreign power-transmission work, so that their methods must command respect here. The translator is a well-known consulting engineer, a past president of the American Institute, whose reputation should increase the attention secured by this volume. H. W.

Buck, a prominent electrical engineer, has made some additions to a section on allowances for weather and wind conditions so that the results may be better applied to American circumstances.

Valuation of Utilities

REVIEWED BY LEONARD METCALF*

PUBLIC UTILITIES: THEIR FAIR PRESENT VALUE AND RETURN—By Hammond V. Hayes, Consulting Engineer; author of "Public Utilities: Their Cost New and Depreciation." New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. viii + 207. $2, net.

The author's second volume on the valuation of public-utility properties is limited to the field of rate-making. Unlike the first volume[1]—which outlined clearly the more important measures of value, original cost, reproduction cost, market price of the securities, etc., and left to the courts, as a legal question, the interpretation of the results obtained—this book, while nominally adhering to this view, seeks to determine the method which shall be pursued and lays great emphasis on, if it does not practically tie to, original actual cost of the property as the proper measure of the rating base. To the lawyer, engineer and layman, well read in the subject of valuation, the book will be most interesting and suggestive as indicating clearly the apparent trend of thought of the public-service commissions and of many legislators in these matters; but in the hands of those unfamiliar with court rulings, the book may prove dangerous, in that the author has fallen into the error of not making sufficiently clear the fundamental difference between the trend of recent public-service commission rulings and the consistent past position of the courts upon this subject—the former striving for cost, the latter adhering always to value as the proper rating base.

The author's acceptance of investment cost as the fair rating base is indicated by his statement:

> Starting new and operating successfully, the actual capital cost—in the production of the plant, organization and service—is the fair basis upon which the fair rate of return can be earned . . . when the loss in the value of the investment in perishable property arising from depreciation has been restored by the reserves for renewals.

In other words, the investment cost in labor, materials and service, made in good faith in the production of the plant, property and organization required in the production of the service sold to the public, with only such deduction for depreciation as the rates in the past may have provided and methods of accounting used may justify, and without allowance to the corporation of the appreciation in value of its property, so long as this property is dedicated to the use of the public or used in its service. While it is true that the apparent trend of thought on the part of certain of the public-service commissions lends color to this viewpoint, it is not sanctioned by the United States Courts which have consistently adhered to *value* and not cost, as the proper base, though they have recognized in cost one of the criteria of value.

Public-service companies could operate successfully under two quite different methods—first, the right to earn upon the fair value of their property a return commensurate with the risks of the business; second, the right to earn upon the investment cost of the property a guaranteed return commensurate with the nature of this guarantee. The United States Supreme Court has followed the first basis in a long line of decisions. Some of the public-utility commissions lean toward the second, and this is the basis advocated by the author. It is in the failure to make this divergence of views more clear that the danger lies of misinterpretation of the author's statements and views.

The author naturally assumes that the action of the commissions will be fair and untrammeled by political or other influences and calls attention to the danger of making these commissions the financial balance wheel. He says:

> The power of commissions to fix a fair rate of return—assuming the fair capital value established—will inevitably change entirely the methods of financial management which have prevailed in the past. It virtually transfers from the officers of the company to the commissions the financial policy of the company.

It may well be asked whether under present American political conditions the freedom of action of public-utility commissions to raise and lower rates stated by Mr. Hayes to be necessary to fair relations between the corporations and the public exists or can exist. Certainly many intelligent and fair-minded observers who have been studying these conditions believe that at present there is evidence of a generally declining character of service, likely to be followed by greater expenditures by the corporations in the near future, unless the commissions hereafter deal more liberally with them, either in finding value or in the rate of return allowed upon the property values or rating bases determined as heretofore or at present.

In Chapter I the author outlines "the present controversy;" in Chapter II he discusses the ascertainment of fair present value of old and new, regulated and unregulated, successful and unsuccessful public service properties, and competitive and non-competitive conditions; and in Chapter III is treated fair rate of return, including not only the going rate or cost of money but also the necessary profit element to induce private interest in such enterprises. Replacement cost under present conditions is intelligently discussed in Chapter VI, the propriety of including therein proper allowance for administrative, engineering, overhead and contingent costs, interest during construction, preliminary and promotion costs, and development expense or going-concern value being clearly and convincingly set forth. The segregation or classification of some of these items is, perhaps, unfortunate as being at variance with general current practice, but the final results obtained by the author are in accord with present methods. Actual original cost determination of existing property is then discussed, though most engineers would disagree with the author's conclusion that it can usually be determined as readily and accurately as reproduction cost.

The discussion upon going-concern value is one of the best that has yet appeared. Among other methods the author outlines one for determining the reproduction cost of this element of value based upon the reasonable, instead of the actual, rate of return. In this connection it is perhaps interesting to note that quite independently of Mr. Hayes' work and prior to the appearance of his book a similar treatment of this subject was submitted in evidence by the reviewer in the Denver Union Water Co. rating case.

Depreciation is ably treated in the last chapter. The author treats the problem as an accounting one, dis-

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[1]Review in these pages by Mr. Metcalf, Feb. 12, 1914.—Editor.

criminating between the relative desirability in application of different methods as applied to long- and to short-lived properties, and pertinently pointing out that "justice demands . . . that the method employed at the time of appraisal should be the same as that which had been employed by the corporation in the past in creating the reserves for renewals."

The author's adoption of the straight-line method as easiest of application and, on the whole, most reasonable, may well apply to future conditions and in the case of old plants to those the greater part of the property of which is short-lived; but it would do serious injury to old water-works and like properties having long-lived structures, and would in the majority of such cases necessarily require an increase in rates to meet the greater annual depreciation reserves which would be presently involved by it, as compared with reserves determined by the sinking fund or equal annual payment methods.

The book is a thoughtful one, and will prove suggestive to those interested in public-service corporation management or control. The publisher's work is excellent. The index is good.

Steam Valves and Valve Gears

REVIEWED BY JOHN J. FLATHER*

VALVES AND VALVE GEARS: Vol. I, Steam Engines and Steam Turbines—By Franklin DeRonde Furman, M. Am. Soc. M. E., Professor of Mechanism and Machine Design at Stevens Institute of Technology. Second edition, reset and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. x + 253; 300 illustrations. $2.50, net.

This work is a further development of the book noted in these columns by the present reviewer Mar. 14, 1912, which was an outgrowth of a series of notes originally prepared in mimeograph form for the use of students in the author's classes. The book referred chiefly to steam engines and briefly to steam turbines. In the edition under review the matter relating to present-day reciprocating steam engines has been considerably increased and the steam turbine is treated much more completely. A separate volume, now in preparation, on the several types of the internal-combustion engine is to be added.

In this edition, as in its predecessors, the subject is treated entirely from the kinematic standpoint with a view to the actual layout of valve gears and the control of the operating agent.

A feature of the present edition is a collection of the various types of practical prime-mover valves into a few (seven) fundamental forms and a grouping of six fundamental types of mechanism from which all valve-gear constructions may be formed. These constitute a handy and reliable reference group for students and others interested in the various phases of the subject.

Other commendable features are the arrangement of the material, the same as in the older edition, and the presentation of problems to conform with the methods in vogue in the best drafting-rooms where the design of valves and valve gears is being carried on in connection with actual construction.

The first section of the book is devoted to a discussion of the simple steam engine. The elements of valves and valve gears are defined and the Zeuner diagram is deduced. Exercises in the use of the Zeuner diagram follow, and practical methods are given for proportioning the plain D- and the Allen valves, equalizing cut-offs and other phases of the cycle, and for determining the width of ports under varying conditions. The limitations of these valves are also pointed out.

Various valve diagrams are presented in Section II, in which illustrative applications are noted of the Bilgram diagram, the valve ellipse, the Reuleaux diagram, the sinusoidal, and others. This is followed by a discussion of fundamental valve forms (Section III) and valve-gear mechanisms (Section IV). Section V is devoted to a presentation of practical types of valves for reciprocating steam engines, interspersed with various drafting-room problems, which include double-ported valves, Meyer, Corliss and other forms, for which the methods of design are given fully.

In Section VI eccentrics and shaft governors are treated both descriptively and kinematically, with especial reference to the relation of the Zeuner diagram, under varying conditions of service.

This is followed by a discussion of steam-engine valve gears of various types and the design of link motions as applied to locomotives and other engines. This section also deals with floating or self-centering valve gears, steering-gear engines and the uniflow steam engine, including the Ames-Stumpf and Skinner universal una-flow.

The final section (Section VIII) is devoted to steam-turbine valve gears, in which the various methods of control are discussed at length.

The new material which has been added on the subject of the reciprocating steam engine in the present edition includes the "semi-plug" and high-pressure piston valves of the American Balance Valve Co., the Rice & Sargent-Corliss engine, including the Rites and Sargent governors, and directions for setting valves and valve gear, Nordberg valves and valve gears, J. T. Marshall valve gear, Sulzer steam-engine valve gear, Williamson steering gear, and several types of the uniflow steam engine. The Curtis "steam-actuated" and "mechanical" gears, the Westinghouse "direct" and "steam-operated" gears and the De Laval gear have been added to the section on steam-turbine control.

As in his previous presentation of this subject, Professor Furman has been successful in his treatment, which is especially well adapted to the work of instruction. The numerous problems and exercises which accompany the text and the logical methods of procedure suggested for each case are excellent features, which must appeal equally to the teacher of machine design and to the student of engineering.

OXY-ACETYLENE WELDING AND CUTTING, Including the Operation and Care of Acetylene Generating Plants and the Oxygen Process for Removal of Carbon—By Calvin F. Swingle, author of "The Twentieth Century Handbook for Steam Engineers and Electricians," etc., etc. Chicago: Frederick J. Drake & Co. Cloth; 4x7 in.; pp. 190; 76 illustrations. $1. Leather, $1.50.

The publishers have added one more practical handbook to their already long list. In doing so they have continued the high degree of utility generally maintained in previous volumes. There is of course a predominance of description of apparatus and its manipulation, but the theory is given in sufficient outline to make the book more than a rule-of-thumb guide.

A short review of welding processes, the action of welding flames, and the properties and preparation of oxygen

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and acetylene occupies 45 per cent. of the text; the remainder discusses torches (or blowpipes), miscellaneous welding equipment, metal-cutting, and burning carbon deposits out of gasoline-engine cylinders.

Public Health and the Law

LEGAL PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION—By Henry Bixby Hemenway, M. D., Fellow, American Academy of Medicine; Fellow American Medical Association; Member American Public Health Association; Member American Association of Railway Surgeons; Member American Statistical Association. Introduction by John Henry Wigmore, Dean, Northwestern University Law School; Illinois Commissioner on Uniform State Laws. Chicago: T. H. Flood & Co. Cloth; 6x9 in.; pp. xxxvi + 859. $7.50, net.

Dr. Hemenway has produced a unique book in that he has combined in one volume a review of the fundamental legal and many of the basic hygienic and sanitary principles of public-health administration. His viewpoint is that of a physician who years ago was a health officer in a small city and has since followed the progress in health-protective work and made a careful study of its many legal aspects.

The book first reviews in considerable detail the whole field of Federal, state and health administration as affected by constitutions, statutes, local ordinances, court decisions and public policy. These take up the larger part of the volume. The remainder of the book is devoted to special applications, under such topics as quarantine, water-supply, sewage disposal, and medical inspection of schools.

In view of several flattering tributes paid by the author to the engineering profession, including a statement that it might be better to choose a health officer from sanitary engineers than from physicians, it may seem ungracious on our part to point out that in discussing sewage treatment he says that the Imhoff tank "takes the crude sewage and pours out water much clearer than that found in many streams, and practically devoid of bacteria." This is clearly a misconception of the object and the effect of the Imhoff tank, but it may not do much harm in this book.

For the every-day use of the health officer a smaller work, containing less about government in general and more regarding the legal difficulties encountered in public-health work, might be more serviceable, but for those who wish a one-volume survey of the field of constitutional and statutory law, from the health rather than the legal standpoint, the volume promises to be valuable.

ELEMENTARY MECHANICS FOR THE PRACTICAL ENGINEER—By John Paul Kottcamp, Head of the Mechanical Laboratory, Pratt Institute. [Engineers' Study Course from "Power."] New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. vii + 181; 85 text illustrations. $1.50, net.

Mechanics does not lend itself easily to home study. An elementary knowledge of the subject, however, can be obtained by anyone who will study Mr. Kottcamp's book, which comprises thirty lessons prepared by him for publication in *Power*. The author knows how to teach mechanics and has presented his lessons in the clear and concise manner which characterizes his classroom lectures.

STANDARDIZED SQUARE FOOTINGS OF REINFORCED CONCRETE—By Lewis A. Hicks, Structural Engineer, Rialto Building, San Francisco. Stiff paper; 6x9 in.; pp. 62; 14 illustrations; accompanied by chart 16x18 in.

A most elaborate and complete diagram for the design of reinforced-concrete footings has been issued by Lewis A. Hicks, of San Francisco, in the form of a small pamphlet of instructions accompanying a linen sheet carrying the diagram. The methods of solution are founded on the well-known tests on concrete footings conducted by Prof. A. N. Talbot, of the University of Illinois. The pamphlet is entitled "Standardized Square Footings of Reinforced Concrete" and is issued by the author, whose address is the Rialto Building, San Francisco, Calif. Its price is not noted.

Construction Materials

MATERIALS OF CONSTRUCTION; Their Manufacture, Properties and Uses—By Adelbert P. Mills, Assoc. M. Am. Soc. C. E.; Assistant Professor of Materials, College of Civil Engineering, Cornell University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xxi + 682; 346 illustrations. $4.50, net.

The standard textbooks on the materials of construction have been so long standard that in many ways they are far out of date, not only because processes of manufacture, and consequently properties of the material, have changed, but because new, or at least additional, facts about certain materials are continually being discovered. A new book which takes account of these changes in as satisfactory a manner as does Professor Mills' text is welcome. While it makes no pretense to the completeness of the earlier treaties by Johnson and Thurston, it amply satisfies the ordinary wants of both student and practitioner, although frankly directed more to the former than to the latter.

The subject matter as outlined in the chapter heads covers gypsum plaster, quicklime, hydrated lime, hydraulic lime and grappier cements; cements, concrete, building stones, clay products; pig iron, cast iron, steel, alloy steels, non-ferrous metals and timber. The method of treatment is to preface the consideration of each material by a discussion of its ordinary application in engineering construction and a study of its manufacture or natural occurrence. The main treatment is then devoted to a discussion of its physical properties in relation to its use.

PRACTICAL APPLIED MATHEMATICS—By Joseph W. L. Hale, Assoc. M. Am. Inst. E. E.; Associate Professor of Engineering, the Pennsylvania State College; Detailed as Supervisor Apprentice Schools, Pennsylvania Lines East of Pittsburgh and Erie. New York and London: McGraw-Hill Book Co., Inc. Cloth; 4x7 in.; pp. xi + 206; 184 text illustrations. $1, net.

"It is often necessary in the work of the shop to find the sum of two or more numbers or quantities. . . . This process is called addition." This is the way Mr. Hale's book begins, and the simplicity of the beginning is maintained to the end. The book will interest only the veriest beginners in arithmetic; but these are sufficient in number to warrant its publication. After the simplest processes have been explained by text and example, fractions, ratio and proportion, use of rules and formulas, simple equations, cube root and a brief chapter on the metric system are taken up successively.

UNIVERSAL SAFETY STANDARDS: A Reference Book of Rules, Drawings, Tables, Formulæ, Data and Suggestions for Use of Architects, Engineers, Superintendents, Foremen, Inspectors, Mechanics and Students—By Carl M. Hansen, M. Am. Soc. M. E., Consulting Safety Engineer. Compiled under the Direction of and Approved by the Workmen's Compensation Service Bureau, New York. Second edition, revised and enlarged. New York, Philadelphia and London: Universal Safety Standards Publishing Co. Flexible leather; 5x8 in.; pp. 312; illustrated. $3, net.

Safety attachments and guards for machinery in shop and foundry and various devices for decreasing the hazard of dangerous operations are explained and amply illus-

trated in two colors in Mr. Hansen's book recently revised. All the appliances and methods have been approved by the Workmen's Compensation Service Bureau, which is supported by the various casualty companies. Those interested in the safety campaign in shop and foundry will find much of value in this collection of safety methods.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN RAILWAY ENGINEERING ASSOCIATION: Proceedings of Annual Convention Held at Chicago, Ill., Mar. 16-18, 1915; also individual papers as issued in bulletins.—Chicago (900 So. Michigan Ave.): E. H. Fritch, Secretary. Cloth; 6x9 in.; pp. 1558.

ANNUAL REPORTS OF WAR DEPARTMENT, 1914 (in three volumes): Vol. II, Report of the Chief of Engineers, U. S. Army (Without Appendices). Washington, D. C. Paper; 6x9 in.; pp. 1565.

BOARD OF HARBOR AND LAND COMMISSIONERS OF MASSACHUSETTS: Annual Report for 1914. Boston (State House): Frederick N. Wales, Clerk of Board. Cloth; 6x9 in.; 124; illustrated.

BOARD OF SUPERVISING ENGINEERS OF CHICAGO TRACTION: Annual Report covering fiscal year ended Jan. 31, 1913. Cloth; 6x9 in.; pp. 534; illustrated.

This belated report is useful mainly as a record, as many important events in Chicago's traction development have occurred in the past two and a half years.

CHICAGO RAILWAY TERMINAL COMMISSION: Preliminary Report Submitted to the City Council Committee on Railway Terminals. Paper; 6x9 in.; pp. 144; illustrated.

CONSERVATION OF WATER BY STORAGE—By George Fillmore Swain, Gordon McKay, Professor of Civil Engineering in Harvard University; Past President, American Society of Civil Engineers. [Addresses delivered in the Chester S. Lyman Lecture Series, 1914, before the Senior Class of the Sheffield Scientific School, Yale University.] New Haven, Conn.: Yale University Press. London, England: Humphrey Milford. Cloth; 7x10 in.; pp. xvii + 384; 91 illustrations. $3, net.

THE DESIGN OF DRILL JIGS: A Practical Manual—By Andrew N. Haddow. [The "Mechanical World" Series.] Manchester and London: Emmott & Co., Ltd. Cloth; 6x9 in.; pp. xi + 96; 142 text illustrations. 2s. 6d., net.

THE DRAINAGE OF JEFFERSON COUNTY, TEXAS—By H. A. Kipp, A. G. Hall and S. W. Frescoln, Drainage Engineers. Bulletin No. 193. Washington, D. C.: U. S. Department of Agriculture. Paper; 6x9 in.; pp. 40; illustrated.

THE ESSENTIALS OF DESCRIPTIVE GEOMETRY—By F. G. Higbee, M. E., Professor and Head of Department of Descriptive Geometry and Drawing, State University of Iowa. New York and London: John Wiley & Sons. Cloth; 6x9 in.; pp. vi + 204. $1.80, net.

THE FUNDAMENTAL ELEMENTS ENTERING INTO THE MAKEUP OF THE MODERN CITY AND A PLEA FOR A SMALLER CITY—By S. M. Swaab, care Keystone State Construction Co., Pennsylvania Building, Philadelphia, Penn. [Reprinted from Proceedings of the Engineers' Club of Philadelphia.] Paper; 6x9 in.; pp. 53; illustrated.

GRINDING MACHINERY—By James J. Guest. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 6x9 in.; pp. xi + 444; 200 illustrations. $4.20, net.

A HISTORY OF TRAVEL IN AMERICA: Showing the Development of Travel and Transportation from the Crude Methods of the Canoe and the Dog-Sled to the Highly Organized Railway Systems of the Present, Together with a Narrative of the Human Experiences and Changing Social Conditions That Accompanied This Economic Conquest of the Continent—By Seymour Dunbar. (In four volumes.) Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 6x9 in.; pp. 1529; 400 illustrations and numerous colored plates. $10, net.

"HÜTTE": DES INGENIEURS TASCHENBUCH—Herausgegeben vom Akademischen Verein Hütte, E. V. 22nd edition. (In Three Volumes.) Berlin: Wilhelm Ernst & Sohn. 5x8 in.; pp. 1084, 1077 and 1109; 4700 illustrations. Linen, 18 Marks; leather, 21 Marks.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS: Proceedings of Meeting Held at Springfield, Ill., Jan. 27-29, 1915. Chicago (Monadnock Block): E. E. R. Tratman, Secretary. Paper; 6x9 in.; pp. 148; 18 illustrations. 50c.

INDUSTRIAL ACCIDENT STATISTICS: Bulletin No. 157—Washington, D. C.: Bureau of Labor Statistics. Paper; 6x9 in.; pp. 210.

LIMESTONE ROAD MATERIALS OF WISCONSIN—By W. O. Hotchkiss and Edward Steidtmann. Bulletin No. 34. Madison, Wis.: Wisconsin Geological and Natural History Survey. Cloth; 7x10 in.; pp. 136; illustrated.

LOCATION OF FORD ENGINE TROUBLES MADE EASY—A Chart Arranged by Victor W. Page, author of "The Ford Model T Car." New York: The Norman W. Henley Publishing Co. Paper; 25x28 in. 25c.

MANUAL OF SURVEYING FOR FIELD AND OFFICE—By Raymond E. Davis, C. E., Instructor in Civil Engineering, University of Illinois. New York and London: McGraw-Hill Book Co., Inc. Leather; 4x7 in.; pp. xv + 395; 54 text illustrations. $2.50, net.

MUNICIPAL REVENUES, EXPENDITURES AND PUBLIC PROPERTIES, 1913—Washington, D. C.: Bureau of the Census. Paper; 9x12 in.; pp. 378.

RAILROAD COMMISSIONERS OF THE STATE OF MAINE: Annual Report for 1914, with Statistical Tables Compiled from the Annual Returns of the Railroad Companies Operating Railroads in the State for the Year Ending June 30, 1914, including Petitions, Decisions and Rules of the Board—Augusta, Me.: Geo. F. Giddings, Clerk of Board. Cloth; 6x9 in.; pp. 502.

REPORT OF THE BRITISH COLUMBIA HYDROGRAPHIC SURVEY FOR 1913—By R. G. Swan, Assoc. M. Can. Soc. C. E. Water Resources Paper No. 8. Ottawa, Ont.: Water Power Branch, Department of the Interior of Canada. Paper; 7x10 in.; pp. 367; illustrated.

REPORT OF THE EFFICIENCY AND ECONOMY COMMITTEE Created Under the Authority of the 48th General Assembly of the State of Illinois, with Accompanying Reports on Revenue and Finance Administration by John A. Fairlie; The Accounts of the State of Illinois by George E. Frazer; Accounting Administration for Correctional Institutions by Spurgeon Bell; Charitable and Correctional Institutions by James W. Garner; Educational Administration by John M. Mathews; Labor and Mining Agencies by W. F. Dodd; Agricultural Agencies by James W. Garner; Public Health Administration by John M. Mathews; Supervision of Corporations by Maurice H. Robinson; Public Works, Parks and Buildings by C. O. Gardner; Military Administration by Quincy Wright; Civil Service Laws by A. C. Hanford; Secretary of State and Law Officers; Efficiency and Economy Commissions in Other States by A. C. Hanford; Fire Insurance Rates by Maurice H. Robinson; Comparative State of Appropriations by Thomas P. Waters. Cloth; 6x9 in.; pp. 1051.

SANITATION IN PANAMA—By William Crawford Gorgas, Chief Sanitary Officer, Panama Canal; Surgeon General, U. S. A.; Major General, U. S. A. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. 298; illustrated. $2, net.

SEVENTH ANNUAL REPORT OF THE PUBLIC SERVICE COMMISSION OF THE SECOND DISTRICT of the State of New York: Vol. III, Abstracts of Reports of Corporations; Electrical, Gas, Telegraph, Telephone, Steam—Albany, N. Y. Cloth; 9x12 in.; pp. 348.

SHRAPNEL AND OTHER WAR MATERIAL: A Reprint of Important Articles Presented in the "American Machinist" From January to June, 1915. New York and London: McGraw-Hill Book Co., Inc. Cloth; 9x12 in.; pp. 92; illustrated. $1.50, net.

STANDARD CLASSIFICATION OF ACCOUNTS FOR THE USE OF THE CITY AND COUNTY OF DENVER, COLORADO, With Explanatory Statements and Ready Reference Index—By Thomas R. Lill, for the Colorado Taxpayers Protective League. East Orange, N. J.: The Author. Paper; 6x9 in.; pp. 55.

STATISTICS OF RAILWAYS IN THE UNITED STATES for the Year Ended June 30, 1913: 26th Annual Report—Washington, D. C.: Interstate Commerce Commission. Cloth; 9x12 in.; pp. 751.

A STUDY OF BOILER LOSSES—By A. P. Kratz, Assistant in Mechanical Engineering. Bulletin No. 78. Urbana, Ill.: Engineering Experiment Station, University of Illinois. Paper; 6x9 in.; pp. 72; illustrated. 35c.

A TESTING SERVICE: Description of the Equipment, Organization and Work of the Electrical Testing Laboratories, Inc., 80th St. and East End Ave., New York City. Paper; 9x6 in.; illustrated.

A loose-leaf pamphlet describing the great varieties of work carried on by one of the best known commercial laboratories in the country. Facilities are described as provided for standardizing instruments, for testing quality of magnetic, insulating and conducting materials, for shop, laboratory and field tests of machinery, for checking performance of supplies of incandescent lamps, for studying the characteristics of illuminants and illumination, and for a great variety of mechanical and chemical work.

THIRD REPORT OF THE QUEBEC STREAMS COMMISSION, November, 1914—Quebec, P. Q.: O. Lefebvre, Secretary. Paper; 7x10 in.; pp. 101; illustrated, and accompanied by 37 folding plates.

WATER-SUPPLY PAPERS, UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.

No. 342: Surface Water Supply of the Yukon-Tanana Region, Alaska—By C. E. Ellsworth and R. W. Davenport. Pp. 343.

No. 357: Surface Water Supply of the United States, 1913; Part VII, Lower Mississippi River Basin—By N. C. Grover, Chief Hydraulic Engineer; Robert Follansbee and Glenn A. Gray, District Engineers. Pp. 86.

No. 358: Water Resources of the Rio Grande Basin, 1888-1913—By Robert Follansbee and H. J. Dean, including Surface Water Supply of the United States, 1913; Part VIII, Western Gulf of Mexico Basins, by Robert Follansbee, W. W. Follett and Glenn A. Gray. Pp. 725.

Field and Office

A Temporary Support for an Elevated-Railway Bent*

By Harry L. Dlyn†

The necessity of moving a 20-in. water main which crossed the site of a column pier on the White Plains elevated extension to the old subway line of New York City afforded the use of a simple and interesting device to avoid delay in erecting the steelwork. The particular pier was known as No. 179E. Fig. 1 shows the general location of the water main and the necessary changes in its location to facilitate the construction of the concrete pier.

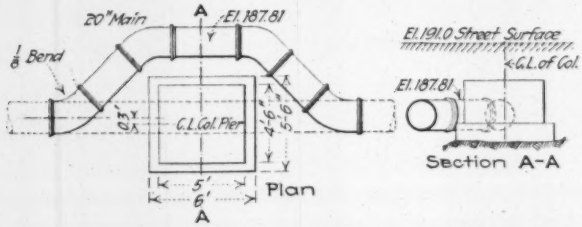


FIG. 1. OLD LOCATION OF WATER MAIN WITH RESPECT TO PROPOSED COLUMN FOOTING

Technical delays held up the moving of the water main, so that the pier could not be built as scheduled. When the steel erection had advanced to bent 179E, something had to be done. The following method was adopted:

Cribwork of 12x12s was laid over the site of the proposed pier to an elevation of 189.18 ft., this being 0.3 ft. higher than the elevation of the finished pier on the west side. Upon this crib the new column was set and held in position by guys fastened to adjacent trees. An A-frame was placed between the tracks of the Union St. Ry., as shown in the view. As soon as the frame was in place the cross-girder was set up over it and securely bolted to the kneebraces and columns. The stringers, cross-frames and diagonal struts were then erected. An additional wood strut was placed diagonally under the east end of the cross-girder, its base being about 10 ft. from the base of the column, as shown in the view.

After the construction of the steel had advanced over the next bent, two upright supports, each consisting of 12x12-in. timbers bolted together, were placed under the easterly longitudinal girders about 10 ft. on either side of column 179E. The aforementioned cribwork was then removed from under the column, which was then suspended with its base 0.3 ft. higher than the pier. The column showed a settlement of 0.04 ft. the following day and an additional settlement of 0.08 ft. after a lapse of three days, leaving then a clearance of 0.18 ft. between the baseplate and the elevation of the top of the concrete pier. A tilt in the structure of 1½ in. toward the west was discovered, and this was due, undoubtedly, to the greater elevation of the base-plate of the east column. As the top of column 179E had deflected 1½ in. to the west, it was necessary to throw the bottom of that column out of plumb 1½ in. to the east.

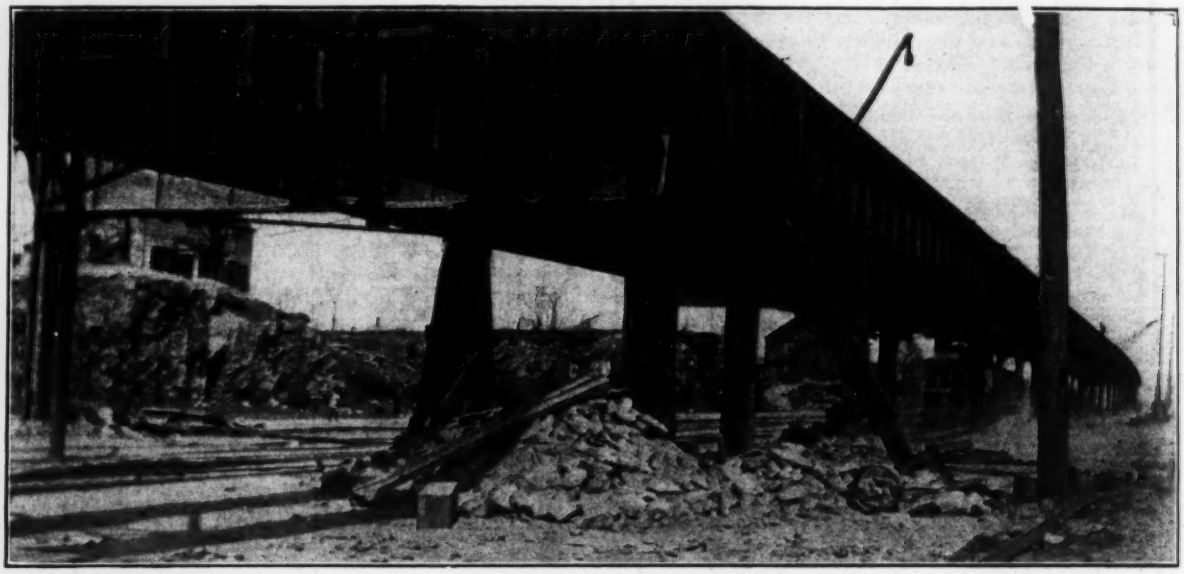


FIG. 2. TEMPORARY SET-UP AT BENT 179E PRIOR TO COMPLETION OF EAST COLUMN FOOTING

When the concrete pier had been built, after the removal of the water main, the anchor bolts were set in place and fastened by wires to the easterly edges of the anchor-

*For comprehensive information concerning the "Design of the Steel Elevated Railways, New York Rapid-Transit System," see "Engineering News," May 20, 1915, pp. 971-977.

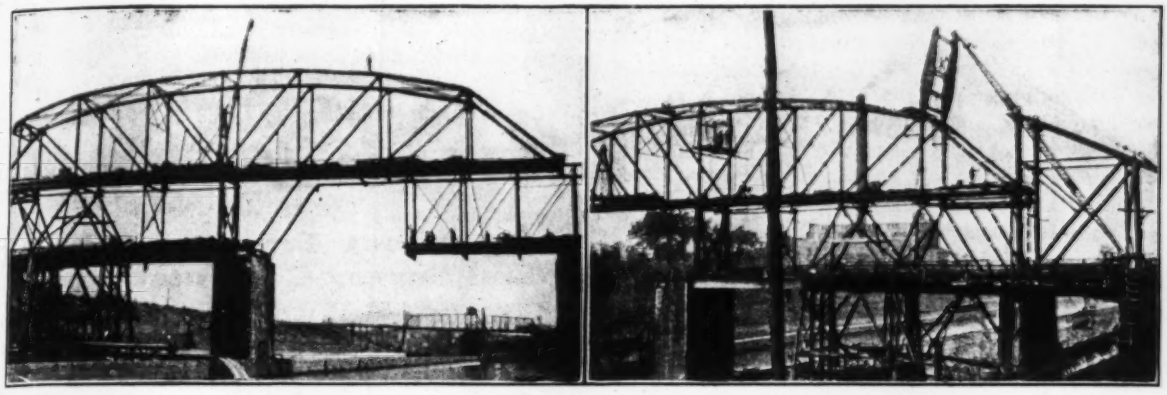
†794 Elsmere Place, Bronx, New York City.

bolt holes of the column base, in order to give maximum play when the column was dropped in place.

The wooden supports were removed seven days after the pier was built, the two uprights being knocked out easily by means of a heavy sledge hammer. With some greater difficulty the inside support also was removed. It was at first intended to have the wedges on the top of the A-frame removed first; but this was found impossible on account of the rivets of the bottom flange of the cross-girder forming grooves in the wood and holding the wedges tightly to the frame. The difficulty was obviated by removing all the bolts connecting the members of the A-frame. An 8-in. length was then cut off the bottom of the center upright of the frame, after which the end posts were easily removed by sledge hammers. Column 179E was then in its place and at its true elevation.

Upon plumbing the column a tilt was still found in the structure, toward the west, amounting to 0.06 ft. This was rectified by placing a 70-ton jack against a 12x12-in. inclined timber resting against the west column. A small load threw the structure into the correct position. The jack was left against the strut until all the riveting had been finished on that bent.

The work was done by the Lucius Engineering Co., subcontractor for the Oscar Daniels Co., under the supervision of the Engineering Department of the Public Service Commission of the First District, New York, for which George Paaswell is engineer in charge of construction. The writer was in close contact with the supervision of this work.



ERECTING A LEVER LIFT BRIDGE AT LOUISVILLE

Left—South half cantilevered and north arm of swingbridge being dismantled. Right—Erection of north lifting link; bridge 17 ft. above final level

Erecting a Lever Lift Bridge

A Strauss lever lift bridge spanning the Louisville & Portland Canal at 18th St., Louisville, Ky., was completed June 23, 1915. It has a clear span of 210 ft., with approach spans of 85 ft. and 75 ft.; the lift is 40 ft., giving a clearance when raised of 90 ft. above normal stage. It is the second bridge of this type in the United States, the first being much smaller. The full lift requires 1½ min.

The new bridge replaces a swingbridge of 187-ft. span, the change being made necessary by the widening of the canal. The south half of the new bridge comes over the north arm of the swing-span. As the latter had to be left free so as not to interfere with navigation, it was necessary to build the new bridge about 17 ft. above the old one and to erect the south half by cantilevering.

A new abutment, of concrete, 24x10 ft. by 52 ft. high, was built on the new north bank of the canal. A temporary trestle was built across the new portion of the canal as an approach to the swing-span. The new north approach span was then erected, its alignment being to one side of the old bridge. In starting erection on the main span, falsework was built up from the temporary approach trestle. When the old north abutment was reached (about midlength of the new span) a bent composed of six 12x12 timbers was built as an outboard support, and from this point the span was cantilevered.

Steel in the approach and part of the main span was placed with a stiff-leg derrick with an 85-ft. boom. A mule traveler with a 50-ft. boom then took up the work, being operated by the same engine.

One big day's run was made, when nearly all the steel in the cantilevered portion was placed and bolted, and on the same day from this part of the new bridge the members of one side of the swingbridge were removed, the rivets having been burned off previously. As fast as they were removed the traveler carried the members to the other side of the swingbridge and placed them on wagons.

When the south bank was reached another bent was built over the old pivot-pier and the south end of the new span supported on it. The remainder of the old bridge was then removed.

The lift-span is carried at each end by levers of truss construction, resting at its middle on trunnion bearings. Counterweight hangers, 25 ft. long, on the outer ends of the levers carry counterweights each consisting of two reinforced-concrete blocks totaling 60 tons in weight. (The span weighs 120 tons.) The tender's house, suspended between the top chords in the middle of the bridge, is of stucco on expanded metal. The lift is operated by two 5-hp. motors located on the outside of the bottom chord. The motors are provided with an automatic stop to halt the bridge when it is within 6 ft. of the full opening, while a spring switch is furnished which must be held closed to allow a greater lift. Hand-operated turning levers for use in emergency are located at each end of the main span. A feature of the operating devices is that five signal lights show the height of the bridge to the tender. Electrically controlled safety gates are placed at each end of the bridge, interlocked so that

the operator cannot throw in the switch to lift the bridge until he has closed the gates.

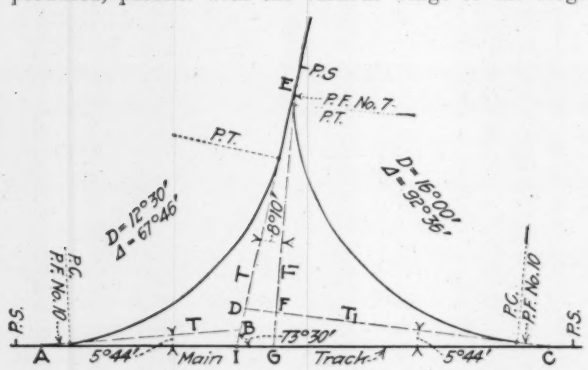
The bridge was erected in 60 working days, the erection being marked by the fact that there was not an accident of any kind. The contractor was the Middle States Construction Co., of Columbus, Ohio. L. E. Breithaupt was in charge of the construction. L. E. Louckes was engineer for the Government. The cost of the superstructure was $50,000.

Location of Frogs for an Unsymmetrical Y-Track

By G. W. White*

The writer recently had the following problem to solve: A spur-track tangent intersected the main-line tangent at I at an angle of 73° 30′. It was desired to put in a Y-connection, using a No. 10 frog and a 12° 30′ curve for one leg and No. 10 and No. 7 frogs with a 16° curve for the other leg of the Y. Frog tangents 10 ft. long were to be used.

To find the location of the frogs, draw the lines AB, CD, EG, these being the tangents through the frogs, produced, parallel with the turnout wings of the frogs



LOCATING FROGS IN AN UNSYMMETRICAL Y-TRACK CONNECTION

and on the center of the spur tracks. The distance from the theoretical frog points to the points A, C, and E, where these lines intersect the main-track center lines, is ng, n being the frog number and g the gage of track. This is true of all frogs located on tangent. For standard gage this is 47.08 ft. for a No. 10 frog and 32.96 ft. for a No. 7 frog. Calculate the tangent distances T and T_1 for the two curves. These are 308.43 ft. for the 12° 30′ curve and 375.95 ft. for the 16° curve.

Then

$$AB = 47.08 + 10.00 + 308.43 = 365.51$$

$$AI = \frac{\sin 67° 46'}{\sin 73° 30'} \times 365.51 = 352.87$$

$$IB = \frac{\sin 5° 44'}{\sin 73° 30'} \times 365.51 = 38.18$$

It is not necessary to have the distance IB, but it gives a good field check on the calculations.

To run in the connection, locate the P.T., B, and A, and mark actual point of frog 47.08 + 0.42 = 47.50 ft. from A toward I. Also mark point of switch at standard lead distance back of frog point. From A turn the frog angle (5° 44′) and set the P.C. of the curve 57.[illegible] ft. toward B, which may serve as a foresight in running in the curve.

For the other leg of the Y

$$CF = 47.08 + 10.00 + 375.95 = 433.03$$

$$FG = \frac{\sin 5° 44'}{\sin 81° 40'} \times 433.03 = 43.72$$

Then

$$EG = 32.96 + 10.00 + 375.95 + 43.72 = 462.63$$

$$EI = \frac{\sin 98° 20'}{\sin 73° 30'} \times 462.63 = 477.40$$

$$IG = \frac{\sin 8° 10'}{\sin 73° 30'} \times 462.63 = 68.50$$

$$CG = \frac{\sin 92° 36'}{\sin 81° 40'} \times 433.03 = 437.20$$

Then

$$CI = 437.20 + 68.50 = 505.70$$

The frog points and curve points may then be located, and the connection run in as for the other leg of the Y.

More About Traverse Tables and Survey Computations

By E. E. Thum*

I have found that Guerdon's traverse tables are extensively used by engineers in the Rocky Mountain region. Such tables reduce the work of computing latitudes and departures to a minimum where the courses are expressed in whole minutes. In passing, it might be mentioned that the engineer uses latitudes and departures perhaps less to compute areas than to calculate coördinates for mapping, or to determine a closing course to arrive at a certain point.

In close work the transitman will double each angle, the angle used being taken as half his final reading. Should this be an odd minute, the courses will naturally read to half minutes; therefore, in such work or in adjusted traverses it is quite common to deal with half or quarter minutes, in which case the traverse table is of small use.

The experienced office man finds that he can use a five-place table of natural functions reading to minutes, such as is found in any fieldbook, interpolating halves and quarters mentally (as the maximum tabular difference will be 0.00030), and by "contracted multiplication" get his latitudes and departures as easily and rapidly as in any other way. An example will show the method:

S 44° 10½′ E 623.85 ft.

By mental interpolation the following natural functions are written directly from the table:

cos = 0.71721 sin = 0.69685

By ordinary multiplication we would have (partial products are shown at the side):

cos = .71721	
dist. = 623.85	
35.8605	= 5 × 7.1721
573.768	= 8 × 71.721
2151.63	= 3 × 717.21
14344.2	= 2 × 7172.1
430326.	= 6 × 71721.
447431.4585	

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*Assistant Professor of Metallurgy, University of Cincinnati, formerly Engineer in Charge of Construction, Anaconda Copper Mining Co., Great Falls, Mont.

The figures to the right of the periods are useless in the final result and "contracted multiplication" eliminates them, thus:

cos	= .71721
dist.	= 623.85
35	= 5 × 7
576	= 8 × 72
2151	= 3 × 717
14344	= 2 × 7172
430326	= 6 × 71721
447432	
lat.	= 447.43

The corresponding departure in a similar manner is 431.73.

For courses below 25° or above 65° it will be handier to use the versine instead of the cosine of the angle; a table of versines need not be consulted, however, as they can be written directly from the table of cosines. Remember that the versine is equal to one minus the cosine, and subtract each digit of the latter from nine except the last, which subtract from ten. For instance the line:

S 24° 19¼′ W 397.25 ft.

cos	= .91124	dist.	= 397.25
dist.	= 397.25	sin	= .41185
vers	= .08876		
			20
	24		320
	280		397
	3176		3972
	31776		158900
correction	= .35256		163609
dist.	= 397.25	dep.	= 163.61
correction	= 35.26		
lat.	= 361.99		

Notice that it is usually preferable to use the function for the multiplier.

For courses below 8° or above 82° the correction can be figured on a slide-rule:

N 8° E 512.45 ft.

cos	= .99027	dist.	= 512.45
vers	= .00973	sin	.13917
dist.	= 512.45		35
correction	= 4.99		51
			4608
lat	= 507.46		15372
			51245
			71311
		dep.	= 71.31

Casting Concrete-Slab Bridges for the Pennsylvania R.R.

By LeRoy M. Schrufer*

An interesting as well as economical method of casting and handling reinforced-concrete slabs for use in the construction of flat-slab concrete bridges of spans up to 30 ft. in the clear is being used by the Pennsylvania R.R. Co., with a centrally located assemblng plant at Pomeroy, Penn.

The site chosen for the concreting plant is located along an old spur of track, with direct connections to the main line and other important branches, and extends for several hundred yards between high hills covered with shade trees and foliage which protect the workmen to some extent from the hot rays of the sun and direct winds. It is so located as to be of easy access for the delivery of materials that go to make up the finished slab, such as the heavy steel reinforcing frames, cement, sand, crushed stone, lumber, machinery, etc. Furthermore, the site is established at such a centrally located vantage point on the division that the finished concrete slabs weighing up to approximately 75 tons can be readily transported over a comparatively short distance in opposite directions to reach the different points on the division and unloaded direct at the bridge site, and in most cases direct from the

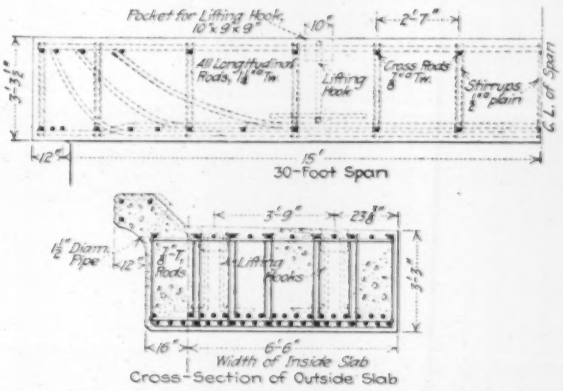


FIG. 1. DETAILS OF FLAT-SLAB BRIDGE

car to the bridge seat, and then slid into proper position without delay to traffic.

Method of Constructing Slab Forms

The old method of constructing a form composed of wooden bottom and sides for each slab was thought to be too expensive and a concrete platform or pavement, 210 ft. long by 20 ft. wide, to accommodate a large number of slabs at one time, was built. An extra-heavy floor or pavement was desired in order to provide for the heavy loads of a number of slabs at one time; it was therefore laid with 18 in. of cinder, which was flooded, rolled and thoroughly tamped, and a layer of 12 in. of concrete of a lean mix of 1 part cement, 3 parts sand and 6 parts broken stone was placed, with a top coat 1 in. thick of 1 part cement and 2 parts sand troweled to a hard steely surface and finished level. A curbing of concrete 6 in. above the pavement extended along both sides and at the ends, forming a sort of large pan and acting as a brace for the struts supporting the sides surrounding the slab forms. A wide expansion joint was

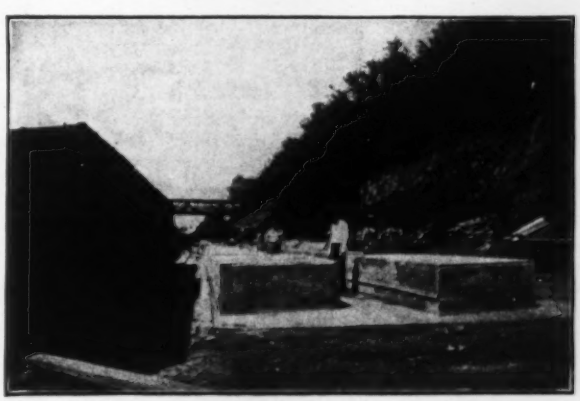


FIG. 2. GENERAL VIEW OF CASTING YARD FOR FLAT-SLAB BRIDGES, PENNSYLVANIA R.R.

made down the center of the length of the slab, with cross-joints every 15 ft. The longitudinal central joint was laid of sufficient dimensions to be used for a gutter to carry off the excess water.

*Engineering Department, Pennsylvania R.R., Philadelphia, Penn.

The work of laying the pavement was started in the early part of this year, and the entire surface was exposed to the elements and allowed to season for several weeks before the work of pouring the concrete slabs was started.

The prime object for the construction of this platform or pavement was to form a substantial and durable sur-

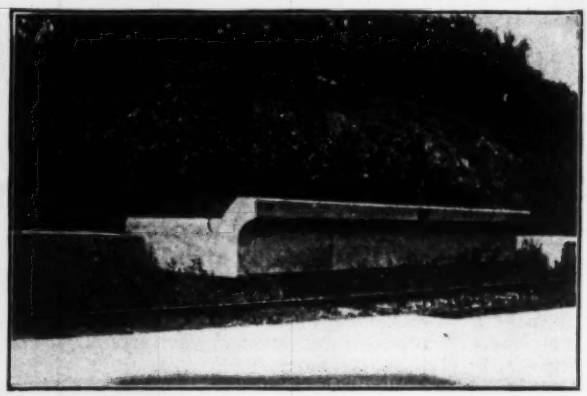


FIG. 3. ONE OF THE CAST UNITS

face upon which to pour the concrete mix direct, so that the same surface could be used over and over again for a large number of slabs, thus eliminating the extra cost of labor and new lumber in building and resetting new wooden base forms. Wooden forms were built in sections for the sides and ends of slabs, but the old method of a wooden floor form was entirely omitted and the concrete was poured directly on the cement pavement form.

Steel Reinforcement for Slabs

The steel reinforcement for slabs (using square twisted bars, one complete turn or twist in 12 diameters) after being fabricated and assembled at a fabricating mill, was unloaded from the cars and placed directly on the concrete pavement, using concrete wedge-shaped blocks to support the lower steel rods and to retain the slab frame at the proper distance from the surface of the pavement in order

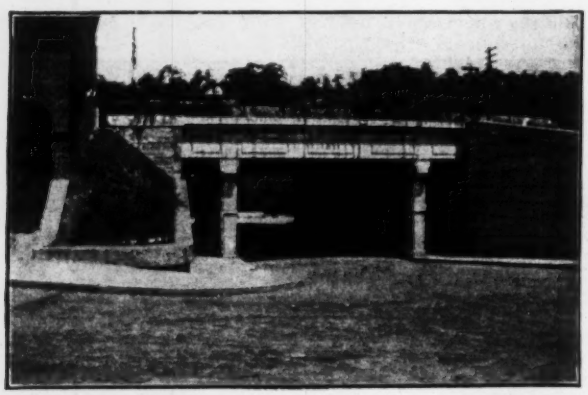


FIG. 4. VIEW OF A COMPLETED UNIT-SLAB BRIDGE

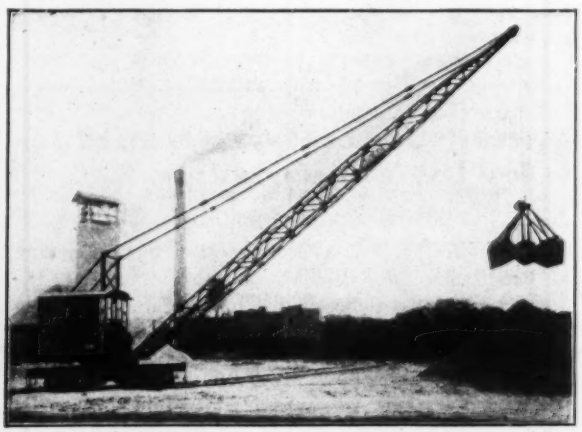
to have sufficient concrete between the lower reinforcement and the soffit of the finished slab (Fig. 1). After the whole slab frame had been lined into exact position and the surrounding wooden forms were placed, the concrete mix of 1 part cement, 2 parts sand and 4 parts ¾-in. stone was poured directly into the form and spaded and worked around the reinforcement.

Before pouring the first slabs on the cement pavement, and as a precaution to aid in preventing possible adhesion between the top surface of the pavement and the slab soffit, a liquid coating of lime paste was applied to the pavement with a whitewash brush. After the surface had received the first few batches of slabs and had been worked over, the above-mentioned precaution was omitted and the concrete poured directly on the pavement, with excellent results.

The steel reinforcement for the slabs was fabricated and assembled by outside contractors at their own plants and shipped direct and unloaded at the site of the assembling plant as previously described. After the concrete is poured to form the slabs and is allowed to set and sufficiently to season (Fig. 3), the slabs are then lifted from the assembling pavement by powerful wrecking cranes, with the lifting chains attached to heavy lifting hooks embedded and concreted in the slab. There are four such hooks to each large slab (two hooks at each end), so designed and placed that each hook takes its calculated proportion of the load or weight of the finished slab. The slabs are then loaded on flat cars and transported to the various bridge sites and finally placed into position with little trouble and practically no delay to traffic. Two such slabs placed lengthwise on the bridge seats generally carry one track and are designed to carry the heaviest types as well as the fastest trains under maximum traffic conditions (Fig. 4).

About 150 bridge slabs have already been cast upon the platform, with most satisfactory results.

Locomotive Cranes at Stone-Crushing Plants—The Knickerbocker Portland Cement Co., Hudson, N. Y., employs a 2-yd., 65-ft. radius electric crane running on a circular track to increase the storage capacity for crushed stone. The plan of



CIRCULAR STORAGE SYSTEM FOR CRUSHED STONE

the company is to work as near full capacity as possible during the summer months so that the quarries may be closed in winter. The present storage capacity is from 50,000 to 100,000 tons. The stone is delivered from the crusher at the quarry to an underground conveyor, which feeds into an elevator located in the middle of the storage area. The elevator discharges the stone at a convenient point, so that it may be rehandled by the 2-yd. grab bucket to the storage area. The idea of using a locomotive crane to increase storage capacity is by no means new. It has been employed for years in storing coal, but its entry into the crushed-stone field is interesting. Patent rights for the circular storage system held by the Link-Belt Co., Chicago, Ill., are claimed to cover the use of a locomotive crane on circular tracks for storing crushed stone.

Building a Sewer Tunnel of Special Concrete Blocks Reinforced*

The city of Edmonton, Alberta, Canada, has recently completed about 11 mi. of trunk sewers in tunnel varying in size from 4 to 10½ ft. in diameter. These were

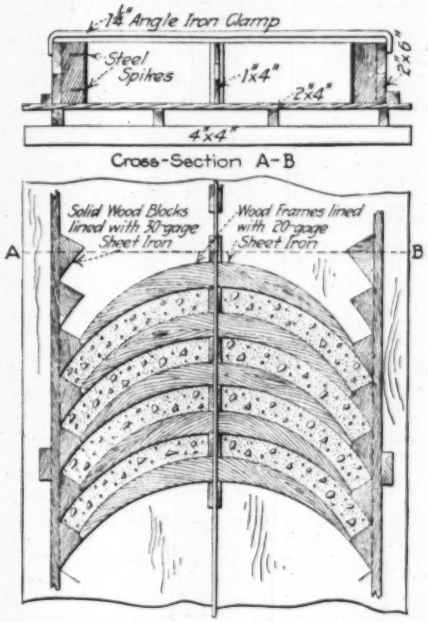


FIG. 1. FORMS FOR CONCRETE BLOCKS OF 5-FT. SEWER TUNNEL, EDMONTON, ALBERTA, CANADA

all built of special 12x4-in. concrete blocks in the form of rings 1 ft. wide, reinforced by steel bars in longitudinal grooves between the blocks and by circular bands or ribs on the outside of the blocks, which are backed by 4 in. or more of plain 1:3:6 concrete. The accompanying table shows the details of the various sizes of sewers.

The tunnels were driven chiefly through a stiff gray clay with occasional pockets of sand. Excavation was carried on from shafts sunk at intervals varying from 200 to 1150 ft. Small charges of dynamite (½ to 1 stick) were used to loosen the clay, and mattocks were used instead of picks. The work was done by electric light. Sand pockets were generally short and caused no special difficulties except in one instance, where the tunnel alignment was changed to avoid a particularly bad place, but before any great expense was incurred.

The block forms were in the shape of gang molds, as shown in Fig. 1. The forms were lined with sheet metal. The blocks were cast on their sides. The concrete (1:2:3) was mixed wet and well spaded into the forms and allowed to set for 24 hr. A considerable number of blocks were rejected because of damage in handling before the blocks had sufficiently seasoned. The arch blocks required special forms which left grooves on both faces of the blocks for placing the reinforcing crown rods shown in Fig. 2.

Blocks and Block Laying

After a length of excavation was completed the subdrain was laid (see Fig. 2) and concrete was placed along the bottom to the grade of the bottoms of the blocks. The lower half of the hooping or reinforcing bands for a ring of blocks was then placed and the invert blocks laid. The remaining blocks to the springing line were added and the backing concrete placed until the lower half of the ring was complete. These blocks were staggered as shown in Fig. 3.

To place the upper half of the ring of blocks, a wooden form or centering extending a short distance back into the finished sewer was used. The reinforcing crown rod, previously bent to the proper radius, was placed in position against the face of the previous ring and the block laying completed around the arch. The crown blocks, of course, could not be staggered. Care was taken to fill the joints between the blocks thoroughly, so that the reinforcing bar and jointing irons (see Fig. 3) would be surrounded by and bedded in the mortar.

When the last block had been placed in the crown of the arch, the upper half of the hooping band was put on, the halves being connected by (patented) coupling shoes (Fig. 4) and tightened by wrenches. The backing concrete was then placed and the laying of the next ring of blocks proceeded.

The junction of the block rings between two shafts was accomplished by measuring the gap as it grew narrow and so adjusting the widths of the joints between the rings of blocks as to make the last ring just fit. If

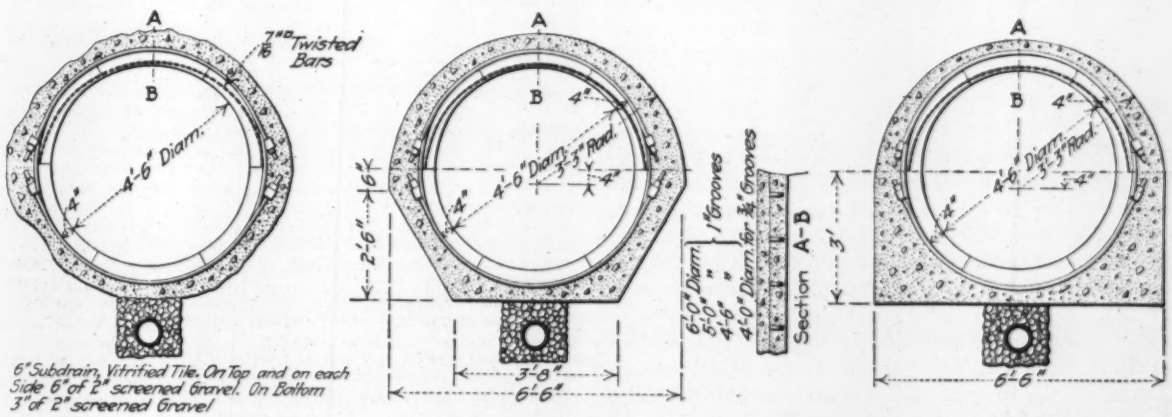


FIG. 2. CROSS-SECTION OF 4½-FT. SEWER TUNNELS MADE OF SPECIAL CONCRETE BLOCKS

*From a paper by A. J. Latornell, City Engineer of Edmonton, Alberta, Canada, read before the Canadian Society of Civil Engineers, Apr. 8, 1915, supplemented by additional information from the author.

this resulted in too great width of joints, the blocks were cut to fit, but generally this was not necessary. The gap in the upper part of the ring was closed with mass concrete, forms being used to hold the concrete in place. The

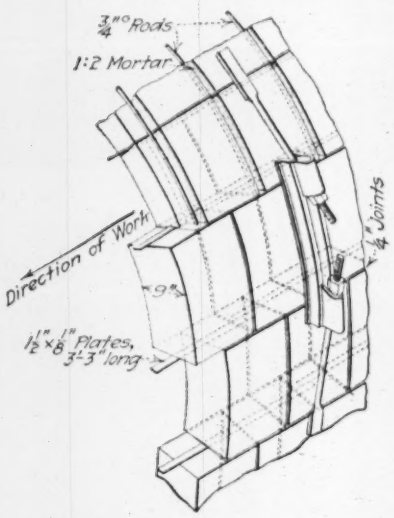


FIG. 3. ISOMETRIC VIEW OF CROSS-SECTION OF 10½-FT. SEWER TUNNEL

last small portion of the crown was lifted or shoved into place. After the concrete had set and the work smoothed off, the junction between the two sections was barely noticeable.

The work was carried on in two 10-hr. shifts, the same men doing both the excavating and the block-laying.

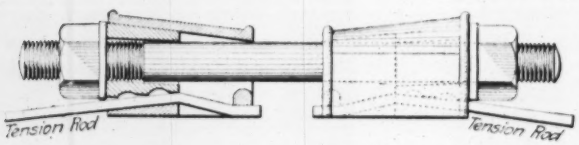


FIG. 4. LUGS PATENTED FOR FASTENING TENSION BANDS

In the 4½- and 5-ft. sewers two men worked in the heading, one man as car pusher and two or three men at the top of the shaft, exclusive of the hoistman and foreman. On 6-, 6½- and 8-ft. sewers three men worked in the heading and two men were car pushers. The progress per week was 30 to 36 ft. of completed sewers in each heading.

The contract prices varied fairly regularly, from $24.25 per lin.ft. for a 4-ft. sewer to $55.15 for 9½-ft. sewers. The cost for the 10½-ft. outflow sewers was less ($50.36), because much of it was in open cut. The cost per linear foot of building the 9½-ft. sewer was distributed as follows: Excavation, timbering and spoil disposal, $17; making and laying concrete blocks and for joints, $16; concrete backing, $8.40; reinforcement and subdrains, $13—a total of $55.15, as noted. The cost of the 4½-ft. sewer was $6.90, $5.40, $3.60, $7.03 and $22.93 respectively.

The city engineer of Edmonton is A. C. Latornell, and the consulting engineer in charge of the design was Alexander Potter, New York City.

STATISTICS OF CONCRETE-BLOCK SEWERS, EDMONTON, ALTA.

Diam. Ft.	Diam. In.	Concrete: Thickness Blocks In.	Concrete: No. of Segment	Concrete: Cu.Yd. per Lin.Ft. Blocks	Concrete: Cu.Yd. per Lin.Ft. Backing	Steel Dimensions: Crown Reinforcement	Steel Dimensions: Circumferential Bands		Steel Dimensions: Longitudinal Straps In.
4	0	4	6	0.17	0.19	3/8	To resist	6	1 x 1/8
4	6	4	6	0.19	0.21	7/16	hydrostatic	6	1 x 1/8
5	0	5	6	0.25	0.24	1/2	pressure	6	1 x 1/8
6	0	5	10	0.31	0.28	1/2	at unit	10	1 1/2 x 1/8
6	6	6	12	0.40	0.33	5/8	stress not	12	1 1/2 x 1/8
8	0	7	18	0.56	0.37	5/8	exceeding	18	1 1/2 x 1/8
9	6	9	24	0.90	0.54	1	elastic	24	1 1/2 x 1/8
10	6	9	24	0.97	0.74	3/4	limit.	24	1 1/2 x 1/8

NOTES

Planning Formwork Ahead—Some years ago, when we simply sent the foreman a set of blueprints of the building and said, "Go ahead and build it," leaving him to work out his own form designs, column forms used to cost, for direct labor, as much as 18c. per sq.ft., and floor forms 12c. Now we spend much time in the office making plans, sometimes as many as 45 sheets of form details for a simple building. These designs may cost 0.2c. per sq.ft. of formwork. But now if the cost for labor for floor forms runs over 4c. per sq.ft. we want to know what is the matter; if it runs over 7c. for a column we usually make a row. We have come to the conclusion that a dollar spent intelligently in the drafting-room usually saves ten on the work, and sometimes more.—Leonard C. Wason, President Aberthaw Construction Co., Boston.

Dry Mortar Bed for Brick Pavements—Sand and cement (or dry mortar) cushions are used extensively for wood-block, asphalt-block and recently experimentally for granite-block pavements. Dalton Moomaw, Road Engineer of Cuyahoga County, Ohio, is now experimenting with a dry mortar bed for brick pavements. The sand and cement are mixed dry in the proportions 1:3 and spread to a depth that when struck and rolled a 1-in. cushion is formed. A hand roller weighing 250 lb. is used. The preparation of the sand-cement cushion proceeds ahead of the placing of the brick only so far as the pavement can be completed before stopping work for the day. The bricks are rolled only enough to obtain an even surface, and when the rolling and culling is completed the pavement is sprinkled from a spraying nozzle until sufficient water is applied to insure wetting the cushion to its entire depth. Grouting the joints follows the wetting of the cushion and is completed as far as the bricks are laid. If weather conditions do not permit grouting on the day the bricks are placed, the pavement is covered and protected against rain and wash.

Ballasted Street-Railway Tracks in Dallas, Tex., have been in service under a traffic of 1500 cars each day since December, 1912, and have shown absolutely no defects either in track or in the street paving (which is of creosoted wood block), according to B. R. Brown, Superintendent Maintenance-of-Way, Dallas Consolidated Electric Street Ry., in a paper presented at the 11th annual convention of the Southwestern Electric and Gas Association, held in Galveston, May 19-22. This statement is especially interesting in view of the experience in Baltimore related in "Engineering News," May 6, p. 884, and the short article entitled "Practice in Paving Street-Railway Tracks," on p. 888 of the same issue. In Baltimore the stone-and-gravel ballast did not prove to be satisfactory under very heavy traffic, cracks in the asphalt appearing adjacent to, and parallel with, the tracks. Mr. Brown states further that within the last year or so this type of construction has gained much favor in the larger Northern cities, but that in the South the solid-concrete base has been adhered to. However, he says, if the subsoil is mucky, soft earth, or quicksand formation, or if the district is poorly drained, a concrete base should be used.

Automatic Track-Inspection Cars are to be used on the Chicago Great Western Ry., which recently purchased four machines from Willis C. Squire & Co., of Chicago. They are of the type invented by T. Ellis, roadmaster of the Northern Pacific Ry., and described in "Engineering News," June 4, 1908. The apparatus is carried on a light three-wheel frame, which is hauled by a motor inspection car. Two pens trace diagrams on a continuous roll of paper. One of these diagrams indicates the surface condition, with superelevation on curves and vertical irregularities such as low joints, etc. The other diagram indicates variations in the gage of the track.

Editorials

More Steel in Bridges

Present low steel prices emphasize and reinforce a movement that has been going on steadily for some years past. Structural design in times gone by had as its ideal the production of structures of minimum quantity of steel. Excellence of general design, soundness of details and resistance to the various attacks of time were neglected elements in comparison with the matter of satisfying certain computed stresses by the fewest pounds of steel. We are in a period of reaction from this school of design. The movement is toward heavier, more substantial design.

Sound designing is not a mere problem of arithmetic, in engineering any more than in architecture. There are many factors vital to the finished structure which do not appear in the force polygon. To take them into proper account calls for a well-ripened judgment; their requirements will often conflict, and the solution must be a compromise.

Let an instance of this be taken in the old and yet obscure conflict between flexibility and rigidity of structure. In past times this was responsible for the existence of two different groups of designers—one aiming to cushion impact and damp out vibration by building resilient structures, the other holding to the view that the most rigid and solid support, a rocklike absence of all yielding quality, is the ideal structural condition. The opposition between these views still exists in part, but we have progressed a little, and know that both views are partly right. What we seek therefore to produce today is an aggregate that contains both rigid and yielding elements, providing flexibility where primary impact is received or where other secondary effects of unmanageable character occur—as expansion or distortion—and, on the other hand, providing a highly rigid construction in the main frame.

This instance well exemplifies how the noncalculable elements of design must be handled on the basis of experience which develops from thorough intimate study of structure, service and material. All the workings of this judgment from experience, however, lie beyond the field of mere sectional-area computations, and may lead to conclusions which seem to violate the requirements of close economy of metal.

Let the inquirer into this subject note the contrast between modern and old-time ideas of good design as expressed in pounds of metal, where a bridge, say, 25 years of age is renewed. He will see, frequently, that the weight of the new structure is four times that of the old one, though designed for not more than twice its load capacity. The excess represents partly insurance, partly a commutation of maintenance expense.

Useful data will be added to this phase of the subject when a railway man takes the trouble to cast up and publish the record of maintenance and repair expense on an old-time bridge which was finally condemned and renewed. Such a record will be certain to form a convincing argument in favor of "ample" design and against the practice of seeking the lightest possible solution of the stress-sheet.

Safeguarding South American Investments

The recent Pan-American Financial Congress at Washington has served to call public attention to the possibilities of a large development of business between the United States and its neighboring countries on the south. It has been repeatedly stated that if manufacturers in the United States are to sell to these countries the goods they formerly purchased from Europe, then capital must be found in the United States for the development of railways and mines and public works in these countries.

While the war continues and for a long period after its close, the European countries that have hitherto been the great reservoir of capital for the development of the other continents are likely to need all their available savings to provide for their own necessities. Those who seek capital for use in other countries on the American continents, therefore, are likely to come to the United States; and the promoters of trade with South America appear to think that it will be easy to dispose of such securities to American bankers and investors.

Before that result is realized, however, investors in the United States may well ask to be shown that the shares or bonds offered are really "securities." The stability of government and of finance in some of the South American countries seems well assured; but in some others revolution and repudiation are too recent affairs to encourage foreigners to risk their money there.

Any responsible American banker who is asked to sell such securities here may well ask, first, What is the attitude of the government in the country where these securities are issued; and second, and not less important, What attitude does the United States government hold toward such investments by Americans abroad?

There is plenty of money in the United States available for investment in any part of the American continents, provided there is reasonable assurance that the government of the country where the investment is made will give a square deal to the man who risks his money, and secondly, that the United States Government will give reasonable support to the legitimate claims of Americans who have loaned money abroad.

It has become the fashion to speak slurringly of "dollar diplomacy" for the reason that a great deal of the financing in connection with concessions and contracts in South and Central American countries has been carried on with more or less corruption. There is admittedly reason in the opposition to the use of the United States Government to collect the claims of American adventurers who may have, through bribery or other illegitimate means, obtained concessions or contracts, which are annulled when some revolution occurs. On the other hand,

where American money has been honestly invested in a foreign enterprise and the government of that country fails to maintain law and order so as to protect it from destruction; or where a government leaves its creditors in the lurch merely because it finds it inconvenient to pay what it has agreed to pay—under these conditions, the American citizen who has loaned his money would seem to deserve some support from his government.

It must be frankly stated that the recent experience of American investors in Mexico—to go no farther southward—has been eminently discouraging to the increase of American investments in Spanish-American countries.

Back of this condemnation of "dollar diplomacy" there appears to be the idea that it is on the whole a rather praiseworthy thing to let the foreign bondholder whistle for his money, and that in notifying the American capitalist who makes an investment abroad that he does it at his own risk, our government is working in the general interest of democracy and popular government, and is condemning the oligarchic plan on which admittedly too many of the Spanish-American governments have been run.

Will this idea stand analysis? Let us see. It is generally agreed that throughout South and Central America the greatest need is an influx of capital to develop the natural resources and give employment to the people who are idle and property-stricken in the midst of vast natural wealth.

If the position of the South American governments and our own government is such that those investing such capital can be assured of reasonable protection to their interests and reasonably fair treatment, they will be willing to loan the money at a much lower rate of interest than will be the case if it is understood beforehand that the risk of repudiation is very considerable. The present Administration appears to be sincerely desirous of increasing the trade relations between the United States and the other American countries, but there is no way in which it can so effectively increase these trade relations and stimulate the investment of American capital in these countries as by giving the assurance that American investors there will be assured of reasonable protection from their own government.

Coast Erosion and Protection

The protection of foreshores against the continual encroachments of ocean or lake is a branch of engineering which has never received its proper attention in the United States, in spite of the fact that this country has a longer water frontage than any other nation. In recent years, however, the increased use, mainly for summer-resort purposes, of the sandy stretches along both oceans and the Great Lakes has brought forward in a most emphatic manner the rapidity with which the littoral currents can wear down an occupied beach and expose expensive structures to the destructive force of the waves. In consequence, on both coasts a great number of engineers, in private practice and in public service, are engaged in the study of what to most of them is a new subject—the protection of these valuable shores against erosion.

It is in recognition of this new interest that *Engineering News* has been presenting to its readers a considerable number of articles on the causes of and protection against coast erosion. A notable addition to these articles is the contribution by R. Bennett on another page of this issue. This will be followed in early issues by a short series of articles by Gerald O. Case, the well-known British expert on this subject, who has devoted the latter part of the last six months to a study of the problem of shore protection on our Atlantic coast.

Recognition at Last

Engineering News has so often deplored the lack of public appreciation of the work of the engineer that it cannot in justice to the often-criticized public refrain from publishing the following brief abstract from the Houston, Tex., *Chronicle and Herald:*

> This city is entering upon a great epoch. For the moment its destiny is in the hands of engineers—more particularly its own engineer. And right here let it be remarked how important the engineer is becoming, and how little recognition his services have received. He is the man who does things, who carries the railroad into waste places, who tunnels the hills, who brings clean water to our doors, who protects public health with sewers and sanitation plants, who digs canals and deepens rivers, who creates and distributes electric power. He is the man with whose work we come in contact on every avenue of life, and upon whose skill and cunning rest in large measure the growth and prosperity of this country.
>
> If somebody writes a trashy book or paints a smutty picture, we rave, call it art, and vote to put a new statue in the Hall of Fame, but the engineer we still consider as rather commonplace, rather tiresome and prosaic.

The occasion of the editorial of which these paragraphs are an abstract is a recent report of the City Engineer, E. E. Sands, on the plans for developing the new ship canal and the harbor which all good citizens of Houston hope will make that city a seaport rivaling Galveston.

Market Quotation for Investment Capital

It has been agreed generally by economists and financiers that the war in Europe with its enormous demands on capital would cause a large increase in the ruling rate of interest. This hardly has been realized as yet in the financial markets of the United States, since the stringency and panic which prevailed during the first two or three months of the war disappeared. On June 29 the City of New York received bids for a bond issue of $71,000,000, bearing 4½% interest. The average price bid for the total issue was 101.272. These bids may be taken to represent the consensus of opinion of the principal bankers and financiers of the United States as to the market for capital in the immediate future. This rate of premium is equivalent to an interest yield of 4.44%. Of course, this represents a radical increase in the interest rate over the 3 to 3½% which prevailed on high-class bond issues in the 90's. On the other hand, it is only a trifling increase, if any, over the ruling rates for capital which have prevailed for two or three years past. It is indeed one of the surprises of the world-war that notwithstanding the enormous demands upon capital in Europe and the cutting off of the sources of capital in so many directions through stagnating business and men out of employment, there is still a vast supply of capital available for investment in the United States so that the New York bond issue was subscribed three times over.

It is to be hoped in the interest of a revival of engineering enterprise, which is so intimately dependent upon the

market for investment capital, that the rate fixed by the New York City bond sale fairly represents what may be expected to prevail for at least two or three years to come. It is a favorable feature for the United States that the public here evidently prefers investment in home securities to purchases of the bonds issued by the warring nations of Europe.

Irrigation Stock and Water Rights Not Related

In one of the most interesting of recent public-service commission decisions, the Kansas board has decided that there can be no relation between the stock of an irrigation-ditch company and the water rights of lands served. The case[1] was that of J. B. Hammon vs. Fort Aubrey Irrigation Co. and involved a number of complaints on complicated legal and administrative matters, out of which this one question stood preëminent.

The Kansas statutes provide that a purchaser of water may continue to purchase, and the board holds that this establishes a water right on the land benefited whether or not the owner holds any stock in the company supplying the water.

The principle involved has a parallel in the idea, generally held to by public-service commissions all over the country, that stock ownership in a public-utility company does not entitle any one to preferential service or rates. All customers stand on a par as customers; the benefits of stock ownership come solely in dividends and such rewards. This has been best expounded probably in the large number of telephone cases decided in the last two years by the Illinois and Wisconsin commissions.

[1] Reported in full in "Public Utility Reports," 1915 C.

Letters to the Editor

Engineering Students Should Practice Public Speaking

Sir—The writer has read with a great deal of interest several articles in your publication relative to the position of the engineer. As I see it, one of the greatest faults of the engineer is that he relies too much on his technical training, and confines himself to an entirely too small a field, taking little interest in the affairs of the day outside of his own chosen profession and not mixing with clubs and organizations as other business men do.

Surely there is no business or profession which is more certainly founded upon sound business principles than is engineering. "Engineering is the theory of economy" expressed in a few words. No engineering business can ever be truly successful until it takes on a sound business system. We have often heard that an engineer is "a man who can do for one dollar what any fool can do for two." How can this be true unless, in addition to technical engineering knowledge, a man employs business methods in his calculations and transactions?

Most engineers are inclined to lack confidence in themselves when it comes to mingling with men of affairs, or else their outward demeanor does not show that this is not the case. We cannot expect to always talk "shop," and in our intercourse with men it is exceedingly important to our success that we be able to converse on other subjects. It is the big, broad man who accomplishes things in this day and age, and we must enlarge our field and become conversant with the events of the day.

We have read a great deal of late in the engineering publications on the subject of public speaking by engineers. Right here is one of the greatest failings of the men in our profession. The engineer should train himself to speak in simple, well-selected, plain words, and be able to show his hearers the advantage to the community at large of engineering works. Surely there is no other profession which should be more interesting to the public than engineering, but the great trouble has been that we have not been trained to present our side of the case.

The engineer should be versed in legal procedure, labor conditions, social problems and all general questions of city, state and country. In order to be successful, he must be able to express himself in good, clear, sound English, and not simply sit back with the air that "I am an engineer and I can make no mistakes," or "you must take my word for it, for you would not understand even if I tried to explain, because you have no technical education."

I have found that the knowledge of legal procedure relative to public improvements which are constructed from funds derived from bond issues or special assessments is one of the most valuable assets.

The writer believes that technical schools could not make a better move as an improvement in their courses than to include one on public speaking. If every student of engineering were required every so often to deliver a lecture on his subjects he would soon lose his "stage fright," and this training would be of incalculable value in life later.

W. L. Benham.

Oklahoma City, Okla., June 5, 1915.

Suggested Military Training for Engineers

Sir—The action of the American Society of Civil Engineers of May 19 regarding a reserve corps of engineers and the editorial on the same subject in *Engineering News*, June 3, 1915, interest me deeply. While there is no doubt that the United States would have the help of most engineers in an emergency I must approve your idea of systematic training.

This training in many, or most, cases would be more to keep the men in practice than in the nature of original instruction, since a very large proportion of all engineers

have had from two to four years' military training in college. In my senior year at college the four cadet captains, the adjutant, the quartermaster and, I believe, a majority of the other cadet officers were engineers. If this can be taken as a criterion—and many state and other universities and colleges prescribe or permit military training—there must be a very large number of engineers in America who are or with very little instruction would become thoroughly capable not only of conducting engineering operations in time of war but of training men in military science as well. In all the talk about military unpreparedness in the last year I have heard no single reference to the quite considerable army of military college men being graduated each year whose service can always be counted on in time of need.

The subject is so broad and of such general interest that I should like to make a suggestion relative to military preparedness, and supplementary to your suggestion of a year's training for engineers. The suggestion comes not alone out of my personal feelings in the matter but from long study and a continual questioning and investigation of the sentiments of boys and young men wherever I have met them. The suggestion embraces, first, a term of enlistment of one year with no reserve, but with extra pay allowance and other advantages for reënlistment. Then the military training during this short term should be more like that given in good military schools but should be for more hours each day so that the recruit would get the same training in his one year of service as he would in two or three at college. Besides his military training, there should be regular courses (say an hour a day at least) in history and geography—history as it is shown us in the biographies of great men and stories of special determining events in the world's and our national life, and geography more like that taught by the National Geographic Society.

There should be schools for mechanical or trade instructions so that every soldier could be taught the rudiments at least of manual training and the operation and care of the more common machines. Fullest provision should be made for play—baseball, football, swimming, bowling and all other games requiring strength or skill. The harder the average American works the harder he wants to play.

Each year some great military campaign should be conducted in which a typical military engineering work would be done in fact or in outline, but preferably in fact, for men like best to work to some definite purpose and will work better if they feel their work is to endure. The officers of this great army (for I have no doubt a great army would soon be created, and I would place the maximum limit high) would be the engineers whom you suggest training. Some of the engineer officers as well as some of the enlisted men would find the life and work to their liking, and sufficient officers for the higher ranks and men for the more important noncommissioned posts would be found. No reserve corps of either would be necessary if the training and instruction were kept on the high plane of idealism where they belong.

For second and succeeding term men the courses of instruction should be advanced so that a young man could spend three or even four years in the army and feel that his time had been profitably spent. In a word, make army life such that any young man could be proud to be a soldier and so that he leaves the service better in every way than he entered it—a better employee, a better associate, a better man.

G. H. Bayles.

Atlanta, Ga., June 21, 1915.

Classification of Technical Literature

Sir—The Joint Committee on Classification of Technical Literature is extremely desirous of obtaining the assistance of your readers in making a collection of classifications of applied science that have been developed independently in the offices of manufacturing plants or engineering firms, especially those that exist in manuscript form and have been used for filing or indexing data.

The committee would especially like to have copies of any extensions of present systems to cover any special industry or branch of engineering not now fully covered by the published classifications.

W. P. Cutter,
Secretary of Committee.

29 West 39th St. New York City, June 21, 1915.

Topographic Surveys for Logging Operations

Sir—I read with interest the article in *Engineering News*, June 10, entitled "Topographic Surveys for Logging Operations," by Earl A. Marshall, of Portland, Ore.

It seems to be Mr. Marshall's opinion that the "Northwest" consists of Washington and Oregon, and his article would leave the impression that the methods of making topographic surveys over the entire Northwest are as described in his article. I call your attention to the fact that the "aneroid method" has been discarded for several years over a large portion of the country generally assumed to be the Northwest.

When District No. 1 of the United States Forest Service first began to make surveys for timber sales, land exchanges, etc., it was found necessary to devise some method of making intensive surveys of rough country that would be both economical and accurate; the aneroid barometer method for determining levels was given a trial, but on account of the aneroid's well-known eccentricities, was soon discarded. Since that time the Abney level method has come into general use, and the results of surveys made by this method have been marvelous.

Mr. Marshall states that the cost of making the aneroid surveys runs 20 to 35c. per acre; by the Abney method the cost is from 8 to 10c. He says, "In leveling over these lines an error of several feet in a mile is of no consequence, as the elevations are to be used only to set aneroid barometers from."

Well, for heaven's sake, what is the use of spending 20 to 35c. per acre if errors of several feet to the mile are of no consequence? With the Abney method, if a man does not check within 4 ft. to the mile, he does the work over. Further, he says, "the draftsman adjusts the closing error, usually marks the adjusted elevations on the map, interpolates for the contours."

This remark alone would justify us in using the Abney in preference to the aneroid, for in the former method there are absolutely no adjustments to make, no juggling of contours and consequent loss of topographic detail.

The Abney method is not an experiment, but has passed through several successful seasons, and is proving its superiority every year; the writer had the privilege of assisting in the design of the special Abney level used for this purpose, and participating in the first trials made with the instrument under the direction of R. V. Reynolds, of the office of Entry Surveys, Washington, D. C. This method has been the method of topographic mapping taught in the Montana University Forest School for some time, and our boys are in demand with the Forest Service and lumber companies for this sort of work.

JAMES H. BONNER,
Professor of Forest Engineering,
University of Montana.

Missoula, Mont., June 17, 1915.

[Professor Bonner has promised to contribute an article describing the Abney level method in detail.—Editor.]

Elimination of Garbage-Reduction Odors

Sir—In your issue of June 24, 1915, p. 1246, I note that a report has been made by I. S. Osborne and others on the elimination of odors in the garbage-reduction works at Barren Island, New York City.

We have had the best of success at Schenectady by exhausting the steam from our digesters into a separate tank which has no connection with any other part of the plant. In this tank there is running water in a compartment about 3 ft. deep, into which the steam is condensed and then discharged into our sewers. With our plant operating at full capacity, we have not been troubled with odors since the installation of this system, at a distance of more than 100 to 250 ft. from the plant. The leakage which causes these odors is now known and will be overcome in the near future.

The other fault we had was the odor arising from the drier, which being improperly constructed did not allow us to pass the air and vapor from the drier over our fires. I removed the pipes that were supposed to eliminate the vapor passing through the scrubber. Behind these pipes I erected two eliminators, which catch all the water forced against them by a blower. The air is dry after passing through the eliminators and is then passed through the fires, where all remaining odors are destroyed.

W. W. CHADSEY,
Deputy Commissioner of Public Works.

Schenectady, N. Y., July 1, 1915.

Long Embedment of Piles in Concrete Piers

Sir—I have read with interest the editorial entitled "Long Foundation Piles" in the issue of June 24, in reference particularly to the Columbia River Bridge and remarking upon the pier design.

The type of pier discussed, involving piles extending considerable distances into the concrete bases, was used both for the Hawthorne Ave. bridge over the Willamette River at Portland, Ore. (*Engineering News*, Mar. 9, 1911), and for the City Waterway bridge at Tacoma, Wash. (*Engineering News*, May 15, 1913), both designed by my firm and involving piers of large dimensions. About two years ago in the office of William Hood, Chief Engineer of the Southern Pacific Co., the writer prepared estimates for the Coos Bay bridge referred to and for certain other bridges, and proposed to Mr. Hood the use of this type of pier, basing the recommendation largely upon the experiences with the large piers of the Hawthorne Ave. bridge.

In one pier of the Hawthorne Ave. bridge, in which the total base height was 50 ft., the piles extended into the base about 44 ft. The base is 23 ft. wide by 47 ft. long and contains 105 piles spaced about 3 ft. centers. The concrete placed under water was deposited through a tremie consisting of a 10-in. wrought-iron pipe equipped at the top with a hopper of about 2 cu.yd. capacity. This tremie pipe was 70 ft. long and was supported by a special derrick, held vertically between the piles, so that it could be raised and lowered at will. After the first charge of concrete was placed, the lower end of the tremie was continually immersed in soft concrete and the full length of the pipe was kept continually filled with concrete. The hopper was filled with successive batches and the tremie lifted slightly after each filling until the pressure was sufficient to force the concrete out at the lower end of the pipe, and as the hopper was nearly emptied the tremie would be lowered and the flow of concrete stopped.

The concrete was mixed very wet, with as much water as the mixers could hold, and about 1000 cu.yd. was deposited without stopping. After pumping out the crib, the surface of the concrete was found to be very hard and dense. The tremie was placed only at the center of the pier and the concrete distributed itself so thoroughly that the elevation of its surface at the extreme corner was only about 2 ft. lower than at the tremie. During the depositing of concrete in this manner, the water contained in the crib was not discolored by laitance.

With such equipment, therefore, the depositing of the concrete in the bases is not exceedingly difficult, but goes forward very readily. The concrete placed above water can be deposited without any particular inconvenience, as it is usual to deposit concrete under water up to within about 2 ft. of the cutoff of the piles. The piers of the bridge over the Fraser River, at New Westminster, are somewhat similar in character, but it is believed that those of the Hawthorne Ave. Bridge, Portland, Ore., are the first notably large piers constructed in this manner on the West Coast.

In connection with the long timbers, the writer was interested in an order placed for the gins for a piledriver 90 ft. high built for the Hawthorne Ave. piers. The gins were single 6x12-in. sticks, and a casual request from the contractor to a sawmill not far above the bridge site for "a couple of 6x12-in. sticks cut from the longest log lying around convenient" brought to the bridge site within an hour two pieces 6x12 in., 110 ft. long, so that 20 ft. was cut off from each to make the gins. For the timber approaches of the same bridge joists 16x20 in. 20 ft. long were required, and the mill sought permission to deliver them 40 ft. long instead, because of the annoyance it caused in the yard to saw them in two. The longer sticks were accepted without prejudice.

E. E. HOWARD.

Kansas City, Mo., June 28, 1915.

U. S. Reclamation Projects produced crops valued at $16,475,000 in 1914, according to an estimate published in the "Reclamation Record" for July. The estimate is based on careful returns obtained from all the projects.

Activated-Sludge Experiments at Milwaukee, Wis.

By T. Chalkley Hatton*

SYNOPSIS—Tests of this new proposed method of sewage treatment on a more extensive scale than has heretofore been reported are described and the results summarized. Glass tubes, two small glass-window tanks, a large fill-and-draw tank and a continuous-flow tank of the same size are included in the studies which are being made at the Milwaukee sewage-testing station. Methods of air diffusion, volume and time of air application and careful cost records are features of the experiments.

For the purpose of comprehensively replying to the very many inquiries received from engineers throughout the country interested in the new process of treating sewage by means of "activated sludge," the writer ventures to report the results obtained thus far in carrying out the process at the Milwaukee sewage-testing station, which is being operated under his direction.

In submitting the information contained herein the writer desires to state most emphatically that he has drawn no final conclusions as to the ultimate applicability of this process for the disposal of the sewage of Milwaukee, as there are many features yet to be studied before such conclusions would be warranted. But the results obtained have given sufficient promise to be helpful to those carrying out similar investigations and to other engineers engaged in sewage-disposal studies.

The purpose of investigating the activated-sludge process was to determine the following points, and the experiments so far undertaken lead to that end:

1. SEWAGE EFFLUENT

(a) Reduction of suspended matters during various detention periods.
(b) Reduction of organic nitrogen during various periods of aëration.
(c) Clarification of liquor per hour aërated.
(d) Removal of bacteria per hour aërated.
(e) Volume of air and pressures necessary to effect the different degrees of purification.
(f) Economic depth of liquor in tank.
(g) Economic method of applying air.
(h) Cost of producing effluent at different degrees of purification.
(i) Effect of temperature on the process.

2. SLUDGE

(a) Proportion of sludge to liquor required to effect different degrees of purification.
(b) Character of activated sludge.
(c) Time and air required to produce activated sludge.
(d) Volume of sludge produced per 1,000,000 gal. of liquor treated.
(e) Best method of maintaining necessary proportion of activated sludge in aërating tanks.
(f) Moisture content of wet sludge produced from aërating tank.
(g) Length of time tank sludge will keep without serious putrefaction.
(h) Value of sludge as a fertilizer.
(i) Dewatering of sludge.
(j) Final disposition of sludge.
(k) Cost of disposing of sludge.
(l) Effect of temperature on sludge.

3. CHARACTER OF TANKS

(a) Fill-and-draw process.
(b) Continuous-flow process.
(c) Combination of both processes.

*Chief Engineer Sewerage Commission, Milwaukee, Wis.

Apparatus Used

On Mar. 6, 1915, a laboratory test was begun particularly to try out the best method of applying air prior to building a working tank. The apparatus for making this test consisted of two glass tubes 5 ft. long and $1\frac{5}{8}$ in. internal diameter, set vertically. In the bottom of one tube a "filtros" plate was inserted.

Filtros is composed of quartz sand and some cementing agent combined under high temperature. It may be made of any required porosity by varying the fineness or coarseness of the sand. It is manufactured by the General Filtration Co., of Rochester, N. Y., and was furnished to Milwaukee in plates 12 in. square by $1\frac{1}{2}$ in. thick.

In the bottom of the filtros plate a small glass tube was inserted through which the air is delivered to the bottom of the plate. This diffuses the air as it comes in contact with the sewage with which the larger tube is filled.

The second glass tube was plugged at the bottom and a small inner glass tube was inserted, with its open end terminating near the top of the plug. The air is discharged through this orifice into the sewage near the bottom, rising up through the larger tube in the form of bubbles, and thus keeping the entire body of the liquor agitated.

These tubes have been in fairly constant operation up to date. Some representative results obtained therefrom are noted at the beginning of Table 1. No attempt was made to measure the air used to obtain these results.

On May 8, 1915, two inspection tanks were placed in operation. These tanks, made of wood, were 10 ft. high, 5 ft. wide, and 1 ft. between sides, the bottom sloping to a 12-in. square in the center. On each side glass plates were inserted at various depths to permit observations to be made of the interior.

In the bottom of one tank a filtros plate was inserted, 12 in. square by $1\frac{1}{2}$ in. thick, and a $\frac{1}{2}$-in. air pipe was attached to the cast-iron frame in which the plate was set.

In the other tank a $\frac{1}{2}$-in. pipe was placed in the center, terminating in an open end within 3 in. of the bottom of the tank.

Meters, U mercury tubes and valves were attached to each air feed to determine and regulate the air pressure and volume.

These inspection tanks were installed for the purpose of investigating the process under high and low temperatures, the economic method of applying air, the volume and air pressure required, the sludge characteristics and the period of sedimentation; also, the most economic depth of liquor to be maintained.

The results are shown in Table 1, under "Glass-Window Tanks." The workmen about the plant have dubbed

them the Annette Kellerman tanks because they resemble somewhat the tanks used by the famous swimmer.

On Mar. 26, 1915, the Fowler tank was placed in operation. This tank is so named because it was designed by Dr. Gilbert J. Fowler, of Manchester, England, who is advising with the writer in investigating this process. This tank is made of wood, 32 ft. long, 10½ ft. wide and 10 ft. clear depth.

Fig. 1 shows how the Fowler tank was constructed. Filtros plates were used as air diffusers. These were built into a concrete channel; but this method was found unsatisfactory because the cinders under the concrete contained the air after the pressure was shut off and, during the sedimentation period, when it is necessary to maintain the liquor as quiet as possible, this entrained air persisted in rising to the surface and keeping the liquid considerably disturbed. To overcome this the plates were placed in cast-iron frames, as shown in detail in Fig. 1, and a ½-in. air pipe was tapped into the bottom of each frame. Since this has been done there has been less trouble with entrained air.

Rebuilding the bottom of this tank put it out of commission from Apr. 14 until May 6, 1915, from which date it has been in continuous operation.

The air delivered to the tank is measured through a Venturi meter and recorded by a manometer furnished by the Builders Iron Foundry. The air for the plant is furnished by a Connersville positive blower of the Boston type, operating to 5 lb. pressure and actuated by a d.-c. motor.

TABLE 1. RESULTS OF ACTIVATED-SLUDGE EXPERIMENTS IN GLASS TUBES AND SMALL TANKS AT MILWAUKEE, WIS.

(Parts per Million)

Date 1915	Temperature, Deg. F. Air	Temperature, Deg. F. Sewage	Aeration, Hr.	Raw Sewage: Suspended Matter	Raw Sewage: Nitrogen As Free Ammonia	Raw Sewage: Nitrogen As Nitrite	Raw Sewage: Nitrogen As Nitrate	Filtros Diffusion: Nitrogen As Free Ammonia	Filtros Diffusion: Nitrogen As Nitrite	Filtros Diffusion: Nitrogen As Nitrate	Air-Jet Diffusion: Nitrogen As Free Ammonia	Air-Jet Diffusion: Nitrogen As Nitrite	Air-Jet Diffusion: Nitrogen As Nitrate	Number of Bacteria per c.c.: Sewage 20°C.	Sewage 37°C.	Filtros 20°C.	Filtros 37°C.	Air Jet 20°C.	Air Jet 37°C.
Glass Tubes in Laboratory (1000 C.c. Samples)																			
Mar. 31	70	48	0	268	16.0	0.08	0.56												
			2	Total				7.0	3.75	2.40	7.5	1.94	1.80						
			4	Solids				0.6	1.50	6.40	4.0	1.10	3.60						
			6					Trace	0.40	8.80	1.6	1.00	4.80						
			8	1247				Trace	0.10	9.12	Trace	0.95	4.80						
Apr. 1	..	..	24					Trace	0.17	10.40	Trace	0.76	11.20						
Small Glass-Window Tanks (Kellermans) Outdoors*																			
May 20	54	51	0	257	12.6	0.24	0.40							763,000	44,000				
			2	Total				8.6	3.7	3.8	12.6	6.0	3.8			142,000		108,000	
			4	Solids				7.1	3.7	14.0	11.1	3.0	7.0			31,500	13,600	52,000	13,500
			24					1.0	0.9	32.0	2.0	8.0	18.0			6,700	1,800	10,700	5,300
Volume of sludge, per cent									.27			27		Volume of water, gal.			124		124
May 22	54	55	0	255	9.6	0.45	2.00							430,000	50,000				
			2	Total				5.0	1.8	12.8	6.6	1.7	10.4			59,000	5,000	52,000	5,000
			4	Solids				2.5	1.5	14.4	4.0	1.5	14.4			80,000	4,000	68,000	1,000
			6	1127				1.0	1.4	16.8	3.0	1.4	19.2			41,000	1,000	11,000	1,000
Volume of sludge, per cent									.28			28		Volume of water, gal.			124		124
May 27	46	52	0	290	9.1	0.42	1.60							1,350,000	120,000				
			2	Total				4.0	0.9	3.8	6.6	2.2	4.0						
			4	Solids				2.4	0.9	12.0	5.0	1.3	8.0						
			6					Trace	0.8	13.6	3.4	0.9	9.0			34,200	3,700	32,000	5,400
Volume of sludge, per cent									.30			30		Volume of water, gal.			124		124
June 11	59	59	0	272	11.6	0.33	1.00							1,070,000	80,000				
			1	Total				7.1	0.08	4.0	8.1	0.20	2.2			74,000	6,000	135,000	12,000
			2	Solids				6.6	0.05	4.2	8.1	0.07	2.4			61,000	5,000	67,000	8,000
			3	1148				6.1	0.16	6.4	8.1	0.10	4.4			96,000	9,000	33,000	1,000
			4					4.5	0.15	8.0	6.6	0.20	5.2			42,000	2,000	26,000	1,000
Volume of sludge, per cent									.18			20		Volume of water, gal.			124		124

* The air was applied to these tanks at an average rate of ¼ cu.ft. per sq.ft. of surface area per min., or at a rate of 605,000 cu.ft. per 1,000,000 gal. per hr. of aeration. The air was applied at following pressures in lb. per sq.in.; filtros, 3.6; air jet, 3.2

TABLE 2. ACTIVATED-SLUDGE RESULTS IN FOWLER TANKS AT MILWAUKEE, WIS.*

(Parts per Million)

Date 1915	Temperature, Deg. F., Air	Temperature, Deg. F., Sewage	Aeration, Hr.	Raw Sewage: Suspended Matter	Raw Sewage: Nitrogen As Free Ammonia	Raw Sewage: Nitrogen As Nitrite	Raw Sewage: Nitrogen As Nitrate	Fowler Supernatant Liquor: Nitrogen As Free Ammonia	Fowler Supernatant Liquor: Nitrogen As Nitrite	Fowler Supernatant Liquor: Nitrogen As Nitrate	Fowler Supernatant Liquor: Suspended Matter	Fowler Supernatant Liquor: Putrescibility	Fowler Supernatant Liquor: Turbidity	Number of Bacteria per c.c.: Raw Sewage 20°C.	Raw Sewage 37°C.	Fowler 20°C.	Fowler 37°C.	Volume of Sludge in Tank, %
June 2	59	58	0	129	12.0	0.60	1.50							2,000,000	230,000			
			1	Total				13.2	1.50	0.30	0	48	Slight			31,000	2,000	9
			2	Solids				15.6	1.30	0.30	0	120	v. s.			19,000	1,000	..
			3	1125				14.4	1.10	0.30	0	120	v. s.			2,000	1,000	..
			4					4.0	....	0.30	0	120	v. s.					..
June 8	56	59	0	135	14.6	0.43	0.60							1,230,000	240,000			..
			1	Total				16.7	0.90	0.40	0	48	Slight			137,000	12,000	..
			2	Solids				17.2	0.90	0.67	0	120	v. s.			51,000	5,000	..
			3	957				18.7	0.90	0.72	0	120	v. s.			46,000	1,000	12
			4					16.2	1.00	0.64	0	120	v. s.			31,000	1,000	..
June 10	48	58	0	170	16.0	0.42	0.60							2,180,000	150,000			..
			1	Total				16.0	0.70	0.50	0	40	Slight			135,000	11,000	..
			2	Solids				15.0	0.68	0.50	0	120	v. s.			110,000	8,000	13
			3	954				17.5	0.70	0.50	0	120	v. s.			170,000	12,000	..
			4					18.5	0.70	0.36	0	120	v. s.			73,000	5,000	..
June 12	57	59	0	223	8.1	0.85	0.60	9.6	0.38	0.70	0	48	Slight	1,000,000	110,000			..
			1	Total				10.1	0.43	0.80	0	120	v. s.			780,000	6,000	12½
			2	Solids				10.1	0.43	0.80	0	120	v. s.			760,000	5,000	..
			3	1026				10.1	0.43	0.70	0	120	v. s.			110,000	1,000	..
			4					10.1	0.43	0.70	0	120	v. s.			34,000	1,000	..

Analyses of Sludge from the Fowler Tank

Date 1915	Specific Gravity	Per Cent. of: Moisture	Solids	Mineral Matter	Organic Matter	Fats	Phosphoric Acid: Total	Phosphoric Acid: Soluble	Parts per Million: Oxygen Consumed	Parts per Million: Total Nitrogen
June 2	1.014	97.7	2.28	0.66	1.62	0.12	1.63	0.33	5,760	1,920
June 9	1.008	97.8	2.16	0.70	1.46	0.13	1.71	0.00	4,000	1,600

* The volume of sewage treated in the Fowler tank is about 15,850 gal. per filling, or 63,400 gal. per day. Air was applied at the rate of ¼ cu.ft. per sq.ft. per min. for 4 hr., or at a rate of 284,000 cu.ft. of air per 1,000,000 gal. per hr., at a pressure of about 4½ lb. per sq.in.

Operation of the Experimental Units

The laboratory test tubes have been operated under varied conditions for the purpose of observing the characteristics of the process, and many interesting results have been obtained which have guided the operations in the other tanks. The record at the top of Table 1 represents the nitrogen cycle obtained with activated

sludge, although 20 to 30 parts of nitrogen as nitrates have been frequently obtained with 24-hr. aëration.

When the two Kellerman tanks were placed in operation on May 8, 25 per cent. of their capacity was filled with sludge which had been artificially aërated for several days, although the nitrogen cycle was not complete. For several days thereafter fresh sewage was added, then aërated for 12 to 24 hr., allowed to settle, and the clarified liquor run off. This process was repeated until the drawn-off liquor was limpid in appearance and the organic nitrogen had been reduced to nitrates; what remained was the true "activated sludge." After this the tanks were operated on 4- and 6-hr. cycles—that is, their contents were aërated for 4 and 6 hr., settled for ½ hr. and then the supernatant liquor was drawn off and the tank refilled in another 1½ hr.

The Fowler tank has been operated since May 6 on a 6-hr. cycle—that is, 4 hr. aëration, ½ hr. settling and 1½ hr. drawing and filling. A small volume of aërated sludge was placed in the tank when starting, but through a break in the connection of the draw-off pipe most of this was lost. However, since May 6 we have been trying to build up the volume of sludge so as to obtain 25 per cent. of sludge to 75 per cent. of liquor, but after 46 days we accumulated only 13 per cent., during which time we treated 2,760,000 gal. of sewage. Measuring the volume of sludge after ½ hr. of settlement, we accumulated approximately 5 cu.yd. per 1,000,000 gal., giving 98 per cent. moisture when drawn.

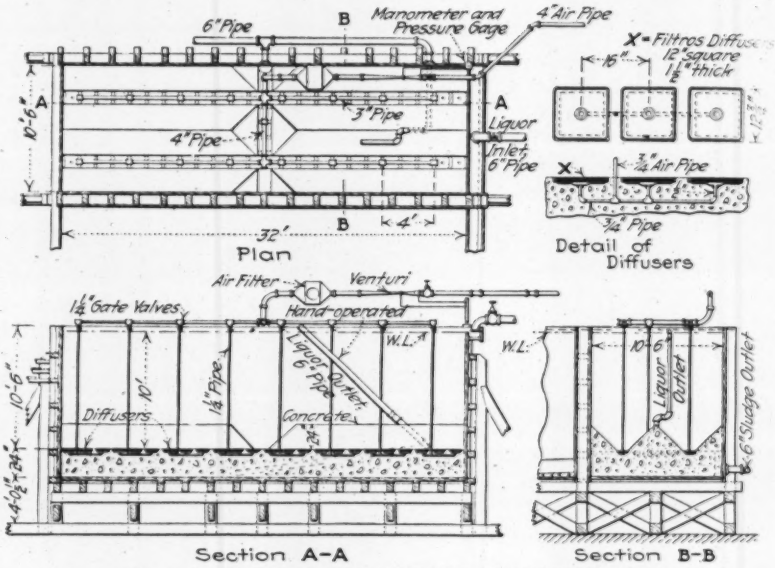


FIG. 1. ACTIVATED SLUDGE TANK AT MILWAUKEE—FILL-AND-DRAW PLAN

Remarks on the Results Obtained

Attention is called to the difference in volume of air used per 1,000,000 gal. of sewage treated in the small glass-window tanks, as shown by Table 1, and in the Fowler tank, as shown by Table 2. The cause of the excess in the former is that only 124 gal. of raw sewage was being added during each run, whereas 255 gal. should have been added to correspond with the same proportion being treated in the Fowler tank. Whether this increased air is the agent by which the effluent from the glass-window tanks is brought up to a higher standard than the effluent from the Fowler tank is uncertain; but the writer is of the opinion that it had very little effect, and that the higher standard is due to the presence of a sufficient volume of good activated sludge, which is not yet present in the Fowler tank.

TABLE 3. BACTERIA IN MILWAUKEE ACTIVATED-SLUDGE TANK DURING DIFFERENT PERIODS OF AERATION*

	Time Sample Was Taken	Total Bacteria per c.c. at 20°	Total Bacteria per c.c. at 37°	Total Red Colonies per c.c.	Percentage of Removal of Total Bacteria at 20°	Percentage of Removal of Body Bacteria at 37°
Coarse screened raw sewage	11:30 a.m.	1,580,000	160,000	100,000	..	..
End of ½ hr. aeration	12:00 m.	240,000	25,000	11,000	85	84.5
End of 1½ hr. aeration	1:00 p.m.	200,000	16,000	7,000	87	90
End of 2½ hr. aeration	2:00 p.m.	120,000	3,000	1,000	92	98
End of 3½ hr. aeration	3:00 p.m.	42,000	2,000	2,000	97	99
End of 4½ hr. aeration	4:00 p.m.	8,000	1,000	.....	99	99.4
Sludge after settlement	4:00 p.m.	14,490,000	1,380,000	370,000	..	..

* This record was made May 28, 1915, when the tank contained only 9 per cent. of activated sludge, on coarse-screened sewage of the strongest character obtained during the 24 hr.

Attention is called to the difference in volume of air used per 1,000,000 gal. of sewage treated in the small glass-window tanks, as shown by Table 1, and in the Fowler tank, as shown by Table 2. The cause of the excess in the former is that only 124 gal. of raw sewage was being added during each run, whereas 255 gal. should have been added to correspond with the same proportion

In studying the results shown in the accompanying tables it must be borne in mind that the process is quite different from the aërating processes which have been investigated from time to time for a generation, in which air was used as an oxidizer and to separate the colloids by agitation or "scrubbing," leaving the colloids to pass off with the aërated liquor and again combine as soon as agitation was over. In the activated-sludge process these colloids combine with the sludge intimately mingled with and at the same time separated from the liquor, and which contains a mass of nitrifying organisms absorbing the organic nitrogen in the sewage.

This is well brought out by two facts. Table 3 shows 1,580,000 bacteria per c.c. in the raw liquor. After 4½ hr. aëration these had been reduced in the effluent to 8000, or 99 per cent., whereas the sludge, after 30 min. settlement, contained 14,490,000 bacteria per c.c. The small glass-window tanks which had been operating with from 25 to 30 per cent. of activated sludge have largely reduced the organic nitrogen to mineral nitrogen, whereas the Fowler tank, which has been operating with from 6 to 13 per cent. of sludge, not completely activated, has shown very little, if any, reduction of the organic nitrogen. That is, the sludge plays a most important part in the process, and to do its best it must be thoroughly activated. Whether it is necessary to have a volume of sludge equal to 25 per cent. of the volume of liquor is a point yet to be determined, but from the results shown by Tables 2 and 3 this does not seem to be necessary in order to get sterilized, stable liquor with 4-hr. aëration. This question will be better answered when results from the continuous-flow tank have been obtained, but it is

one which must be solved, as it figures greatly in the capacity of tanks necessary.

Sufficient information has not yet been gathered to indicate what effect low temperature will have on the process. The Milwaukee sewage effluents from the sprinkling filters at the testing station reached a temperature of 42 deg. F. during the past winter. The small glass-window tanks were started on July 6, 1915, on a series of tests to denote temperature effects, by keeping the temperature of the liquor in the tanks from 40 to 50 deg. F.

Few investigations have been made of the sludge because we have been unable so far to build up enough

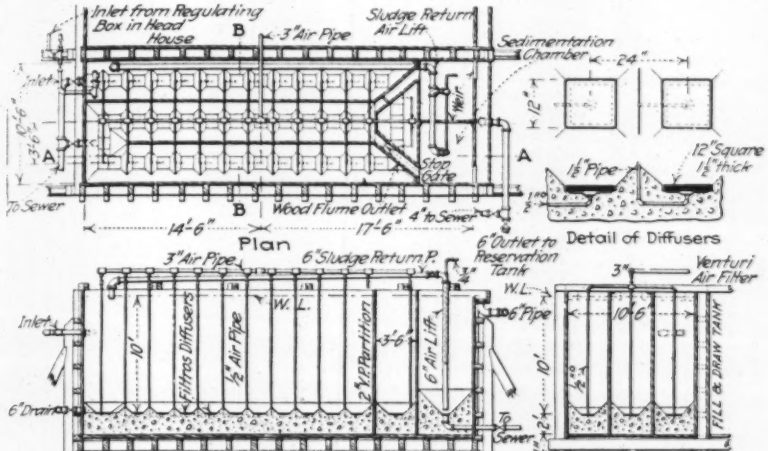


FIG. 2. CONTINUOUS-FLOW ACTIVATED-SLUDGE TANK AT MILWAUKEE

without robbing the tanks. The laboratory tests show a sludge which differs materially from either Emscher-tank or septic-tank sludge. It is not gaseous, like the former, nor does it retain its moisture, like the latter. It is granular in appearance, settles to the bottom, the clarified liquor coming to the surface quickly. That is, in four hours a sludge containing 98 per cent. moisture is reduced to from 75 to 80 per cent. of its volume, containing about 75 per cent. of moisture. The liquid separates from the sludge so quickly and effectually that there need be but little difficulty in drawing it off from a sludge tank and dewatering from the surface as well as from the bottom. The sludge gives off no odor when fresh; after being retained in open bottles for several days it turns from a medium brown to black and putrifies. There is no odor about the tanks while the sewage is being treated.

It is the intention to investigate thoroughly the treatment of the sludge as sufficient quantity accumulates.

From the beginning of the test it has appeared so simple to get a nearly sterile liquor after four hours' aëration, and the whole process has seemed so much more promising in general results than any other of the many processes being tried out at the testing station, that all connected with directing the tests have been fearful lest some overwhelming obstacle would arise which would make the process impracticable.

Several inquiries have suggested that the cost of air would prove to be prohibitive, as has been the case in investigations of other processes. To the end that the writer would not be deceived in this very important item, special attention has been given by all connected with the work to arriving at the cost of air. The best apparatus obtainable for measuring the volume and pressure of air used in each tank have been installed, and these are tested out every week. Every half hour of the 24 hr. readings are taken. The liquor treated is all measured volumetrically. An engineer is in charge of the work both night and day under the direction of William R. Copeland, Chief Chemist, and the orders from headquarters are to record the truth.

So far the cost of air for treating the sewage in the Fowler tank is $1 per 1,000,000 gal. per hr. aërated. This cost is based on electric current at 1c. per kw.-hr., a blower efficiency of 73 per cent. and a motor efficiency of 90 per cent. The sewage commission has been tendered a proposition from the local electric company to supply current in the quantity required for pumping and blowing for 0.77c. per kw.-hr. A blower of 30,000 to 40,000 cu.ft. per min., direct-connected to a steam turbine, will produce power at less cost than the electric unit. So far the cost bugaboo has not materialized. It may appear with winter temperatures.

If this process can be satisfactorily carried out on the basis of continuous flow, both winter and summer, it will far excel every other sewage treatment to date where a stable, sterilized effluent is required. It is especially adaptable to being increased from year to year as population grows by simply adding to tank and blower capacity, and it largely circumvents the fool-killer.

For the purpose of testing the continuous-flow principal a tank of 22,500 gal. capacity has been installed and was put in operation on June 21, and we hope by September next to be able to report some interesting results from it (see Fig. 2). It has been improvised from a chemical precipitation tank which has been thrown out of commission, and is of the same capacity as the Fowler tank.

As stated in the beginning, this article is submitted for the purpose of answering the many inquiries received from interested engineers, and incidentally for giving those parties working along similar lines the information obtained to date at the Milwaukee plant. The writer so far claims nothing except that there is no doubt that the Milwaukee sewage can be treated by this process, during at least eight months in the year, so as to produce a stable effluent at less cost than any of the other processes so far tested in the experiment station under his directions—and these processes have included fine screening, Emscher tanks, chemical precipitation, sprinkling filters, liquid-chlorine disinfection and electrolytic disinfection.

⁂

A Large-Capacity Coal Car for the Erie R.R., exhibited at the Atlantic City convention of the Master Car Builders' Association, is a hopper-bottom car with high sides and has a capacity of 140,000 lb. The dead-weight is 60,700 lb., and it is carried on four-wheel trucks, giving a wheel loading of over 25,000 lb. per wheel. The car body is 40 ft. 6 in. long, 9 ft. 3 in. wide and 11 ft. high. It holds 2646 cu.ft.

Useful New Facts About Materials

The following short articles have all been abstracted from papers, with discussions, presented to the annual meeting of the American Society for Testing Materials, held June 22 to 26, 1915, at Atlantic City, N. J.

A Laboratory Method of Proportioning Concrete

For comparable test-pieces of concrete the ordinary volumetric proportioning of the aggregate does not give entirely accurate results on account of the variation in voids. To provide a more uniform method, J. A. Kitts proposes a weight-volumetric system of proportioning in which the specific gravity and voids in each aggregate are considered and such a proportion determined that all the aggregates will have approximately the same strengths.

Internal Stresses from Hardening

H. V. Wille (Baldwin Locomotive Works, Philadelphia) measured the internal stresses produced in steel cylinders about 9½ in. in diameter by quenching in water and in various oils. The method of study was to cut out rings, measuring their diameter before and after cutting loose. Stresses from 24,000 to 45,000 lb. per sq.in. were found. Only a thin outer skin was in tension and all the remaining cross-section in circular compression. Occasionally internal flaws resulting from the quenching were found. The temperature from which the steel was quenched did not seem to have any particular influence on the result of the hardening.

How quickly and how thoroughly a piece of steel heats up in its interior, when in a heating furnace, was studied by M. E. Leeds (Leeds & Northrup Co., Philadelphia) on field specimens ranging from 2 in. round to 12 in. round. Pyrometers laid against the surface of the specimen remained well ahead of the interior temperature throughout the early stages of the heating, but by the time the exterior of the specimen reached furnace temperature the interior had also reached furnace temperature. Moreover, the exterior temperature when plotted by a self-recording pyrometer correctly showed the time at which the entire specimens reached a transformation point, by an inflection in its curve, in spite of the fact that the indicated temperature of this inflection was higher than the transformation temperature.

With the help of his observations, pyrometric control of the heat treatment of steel is made considerably more precise and therefore serviceable.

Steel Hardness Proportional to Strength

Some 4000 tests of various kinds of carbon and alloy steel subjected to various heat treatments, comprising the determination of tensile strength and of Brinell and scleroscope hardness number, were reported on by R. R. Abbott (Peerless Motor Car Co., Cleveland). It was found that all carbon steels show a straight-line relation between hardness and tensile strength throughout the whole range investigated—from 40,000 to 250,000 lb. per sq.in. tensile strength. The same thing is true of the other classes of steel—nickel steel, chrome-vanadium steel, etc. In each instance, however, the values plotted form a belt rather than a thin line on the diagram, and the width of this belt is sufficient to represent about 20% variation in tensile strength for any given hardness. This extent of variation will probably seriously interfere with making correct practical use of the straight-line relation, as, for instance, by substituting hardness tests for tensile tests of steel in the control of mill and shop operations.

"Fatigue" of Steel

In the important question of fatigue or endurance of steel, H. F. Moore (University of Illinois, Urbana, Ill.) and F. B. Seely, in a paper entitled "The Failure of Materials Under Repeated Stress," attempt to extend the results of observations at fairly high stress (that is, not far below the yield-point) to stresses considerably lower. Adopting an exponential formula for the relation between stress and number of repetitions required to produce failure, they adopt the hypothesis (based on a slender structure of facts available at present) that fatigue phenomena do not have a lower limit of stress, and that an exponential relation holds for low stresses. On the other hand, an exponential formula fitted to those test results which have been obtained at high stresses gives unduly low values of stress for greater number of repetitions; in this range, therefore, the authors propose an arbitrary factor by which the stress calculated from the exponential formula is to be increased. This factor increases with the number of repetitions whose fatigue stress is to be determined. The authors give graphical charts and tables for dealing with the equations they propose.

Concrete-Filled Pipe Columns

Columns made up of pipes varying from a 4-in. lightweight boiler tube to a 6⅝-in. standard-weight steampipe and filled with a 1:2:3 concrete jolted down into place have been tested by F. W. Swain and A. F. Holmes. The tests show that the filled columns were perfectly elastic under loads below the elastic limit. Inasmuch as indicator blocks of the same concrete showed a permanent set after loading, it is apparent that in the filled column the steel tube prevents the permanent set from taking place in the concrete. In other words, the composite column is elastic under working loads and can be so figured. Formulas are given for the kind and quality of columns tested, with constants which permit of alteration to fit other concrete mixtures.

Finer Grinding and Higher SO_3 in Portland Cement

For some time there has been a demand in certain quarters for a finer grinding of portland cement as a means of improving its quality, and in other quarters a claim that the SO_3, added to retard setting could be increased without serious danger. P. H. Bates (United States

Bureau of Standards) reported a series of tests of interest along this line. Ten commercial cements were tested over a period of six months in tension and compression and for expansion—(1) in their original state, (2) when reground so that about 12 per cent. more passed a 200-mesh sieve, (3) with the SO_3 content increased to 2½ per cent. and (4) when reground and with the added SO_3 besides. In the main the author points out the unsatisfactory results obtained, indicating that fine grinding and added SO_3 have not the importance generally ascribed to them. Judicious selection of certain of the test results could prove almost any contention on either side of the controversy. The following abstract is a part of the author's general conclusions:

So far as time of set is concerned, no disadvantageous results have been produced. The fine grinding produces a quicker set; the additional SO_3 produces a quicker initial but slower final set. Few of the changes, however, are such as to place the treated cement beyond specification limits.

Either fine grinding, the addition of SO_3, or fine grinding plus addition of SO_3, generally improves the strength of neat specimens. The neat specimens, however, do not give very consistent results, and not much value should be placed upon them. The indications are that at later periods the results for all neat specimens, including those made from the coarse cements, will be very close together.

The strength of the standard sand mortars in tension shows the advantage of all of the three treatments of the original cements. In the compression test specimens the addition of SO_3 to the coarse cement has caused a falling off of the rate of gain of strength, which might be assumed to be caused by steadily increasing disruptive action.

At the end of 28 days the grand average strength of all the concrete specimens, made from the cements as received, was 2417 lb. per sq.in.; of the specimens made of the cement with the additional plaster, 2635 lb. per sq.in.; of the specimens made from the finer-ground cement, 3103 lb. per sq.in.; and of the specimens made from the finer-ground cement further plastered was 3028 lb. per sq.in. The strength of the concrete of these specimens at the end of 90 days was 3263, 3175, 3828 and 3760 lb. per sq.in. respectively. From these figures it appears that at the end of 28 days, by the above-mentioned treatment, the original amounts have been improved about 10, 28 and 25 per cent. respectively; and at the end of 90 days about 0.0, 17 and 15 per cent. respectively. It would appear, therefore, from these grand averages that at later periods the original cements may give as good strength values in concrete as the treated cements. It might even be assumed that the further SO_3 in the coarse cements was not desirable from the standpoint of strength. It is, however, very evident that finer grinding is very advantageous for early strength, and that the addition of more SO_3 to such finer-ground cements to more properly control their set is not disadvantageous at this period.

The results of expansion measurements on neat specimens stored in water show large increases in length for the specimens made from the cements containing more SO_3. In the sand specimens this is not so apparent. At present these specimens do not furnish much aid in studying the problem under investigation. It may be, however, that these neat specimens are foretelling the ultimate results which will be noticed in the strength specimens.

The results are not conclusive as to the effect of the composition upon finer grinding or further SO_3. Neither can any satisfactory conclusion be drawn from the constitution of the cements.

News of the Engineering World

Important Action on New York Building Code

In the section-by-section revision of the building code of New York City three vital sections were adopted by the Board of Aldermen July 6. They relate to masonry, fireproof construction, and reinforced concrete. In walls, hollow blocks of tile or of concrete are admitted on equal terms with brick, as to wall thicknesses; in skeleton-construction buildings they may be used for all heights, but in other types they are limited to buildings not over 40 ft. high. For exterior surfaces they must be extra-hard burned or else veneered, or else coated with ¾-in. cement stucco. A further important innovation is a section permitting the use of 12-in. curtain walls for the entire height of skeleton structures.

In residence buildings, a minimum thickness of 8 in. is fixed for outside as well as interior walls.

The fireproofing requirements call for a 2-in. thickness of covering except at edges of column brackets or lugs, which may extend to 1 in. from the surface of the fireproofing.

All types of fireproofing are admitted. No pipes or wires may be embedded in the protective material. Conservative methods of design are prescribed for floor arches and the like, with a unit-stress of 500 lb. per sq.in. for stone-concrete and tile, and 300 for cinder concrete. Tile or gypsum block partitions 3 in. thick and 2 in. solid cement or gypsum plaster on metal fabric or studs are allowed.

In reinforced concrete, beam stress is limited to 650 lb. per sq.in. and direct compression to 500; but over supports of continuous beams the stress may be 15 per cent. higher. In columns, vertical steel is counted at 7500 lb. and concrete at 500; the hooping percentage times 2¼ times its unit-stress is the amount allowed as added capacity per square inch of the concrete. The reinforced-concrete ordinance for the first time establishes by law an up-to-date concrete regulation in New York City.

The Structural Engineers' License Law in Illinois

The bill requiring the licensing of structural engineers in Illinois was signed by Governor Dunne on July 5. Normally it would have been signed in June and have gone into effect on July 1, but owing to the protracted session of the legislature this bill (with many others) was not signed until after July 1. It is now a question whether the act becomes effective at once or does not take effect until July 1, 1916.

The act provides for a State Board of Examiners composed of five members, one to be a professor in the Civil Engineering Department of the University of Illinois and the others structural engineers of recognized standing and of not less than ten years' practical experience. Two members are to hold office until Jan. 31, 1917, and three until Jan. 31, 1919. Applicants for license pay a fee of $20, a further fee of $30 if the license is granted, and an annual fee of $10. Structural engineers who are in prac-

tice at the date when the act becomes effective are entitled to a license without examination. The board may grant a license without examination (but requiring the full fee of $50) to structural engineers licensed under the laws of other states. After six months from the date the act takes effect, it will be unlawful to practice without a license.

No corporation may be licensed to practice, but it may prepare plans and specifications for structures (as covered by the act) to be built under its supervision, provided the chief executive officer or managing agent of such corporation in Illinois is a structural engineer licensed under this act. It is lawful for licensed structural engineers to enter into partnership with architects.

At least two examinations must be held each year. The board must adopt rules and regulations for the examinations. Upon the election of each of its officers and upon the adoption, repeal or modification of its rules of government or rules for examinations, the board must publish the name and address of each officer and a copy of the rules (or amendments, etc.) at least twice in one engineering journal of general circulation in the State of Illinois and in one daily newspaper published in the state.

Two of the principal clauses of the bill, defining structures and structural engineers, are as follows:

Structures within the meaning of the act shall be construed to mean all structures other than buildings, having as essential features foundations, columns, girders, trusses, arches and beams, with or without other parts, and in which safe design and construction require that loads and stresses must be computed and the size and strength of parts must be determined by mathematical calculations based upon scientific principles and engineering data.

And any persons who shall be engaged as principals in the designing and supervision of the construction of structures or the structural part of structures designed solely for the generation of electricity, or for the hoisting, cleaning, sizing or storing of coal, cement, sand, grain, gravel or similar materials, elevators, manufacturing plants, docks, bridges, blast furnaces, rolling mills, gas producers and reservoirs, water-works, sanitary works as applied to the purification of water or plants for waste and sewage disposal, or roundhouses for locomotives, railroad shops, pumping or power stations for drainage districts, or power houses, shall be considered as structural engineers within the meaning of this act, and shall be entitled to the benefits of these provisions, even though such structures may come under the definition of "buildings" as defined in an act to provide for the licensing of architects and regulating the practice of architecture, in force July 1, 1897.

Cincinnati Buildings Suffer from Wind Storm

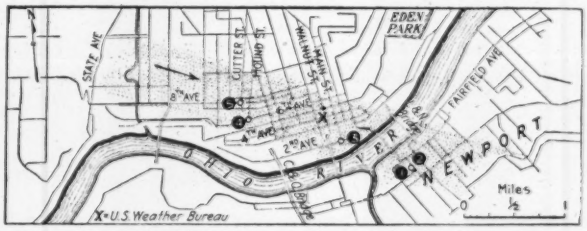
A violent wind, rain and thunder storm swept over southern Ohio and northern Kentucky during the night of July 7, which in the vicinity of Cincinnati resulted in a loss of 37 lives and property damage to the extent of several million dollars. This was the most devastating storm in local history.

A wind velocity of 50 mi. per hr. was recorded on two previous occasions—in 1901 and in 1902. The storm of July 7 establishes a highest wind velocity for the Cincinnati Weather Bureau of 50 mi. per hr. for 5 min., with an extreme velocity of 62 mi. for a period of 1 min. In all probability the wind was more violent in certain sections of the city than the anemometers at the Government Building recorded. The observatory in Clifton, which is about 4 mi. north of the Government Building, showed a velocity of 44 mi. per hr., with an extreme velocity of 50 mi. for 1 min.

According to Acting Weather Forecaster Schlomer, the storm occurred in connection with an eastward movement of a low-pressure area from northwestern Iowa at 7 a.m. on July 7, 1915, reaching northeastern Ohio at 7 a.m. on the next day. At 7 p.m. the area of low pressure was central over Illinois, with Cincinnati in the southeastern quadrant of this area, so that severe storms were probable. The sky during the day was overcast with alto-stratus and strato-cumulus clouds moving from the southwest. At 7:30 p.m. a formation of mammato-cumulus clouds was observed in the zenith. This type of cloud appeared just before the St. Louis tornado in May, 1896.

The wind during the day was from the southeast, with an average velocity of 7 mi. per hr. After 7:30 p.m. the velocity gradually increased, and at 9 p.m. it was blowing at the rate of 20 mi. per hr. from the southeast. This direction continued until 9:29 p.m., when the wind veered to the northwest with a greatly increased velocity. After 9:35 p.m. the wind gradually decreased in velocity, blowing from the northwest until 10.20 p.m., at which time it backed to the south, continuing light until midnight.

A rainstorm began at 8:40 p.m. and ended at midnight, with a total rainfall of 1.01 in. The downpour occurred



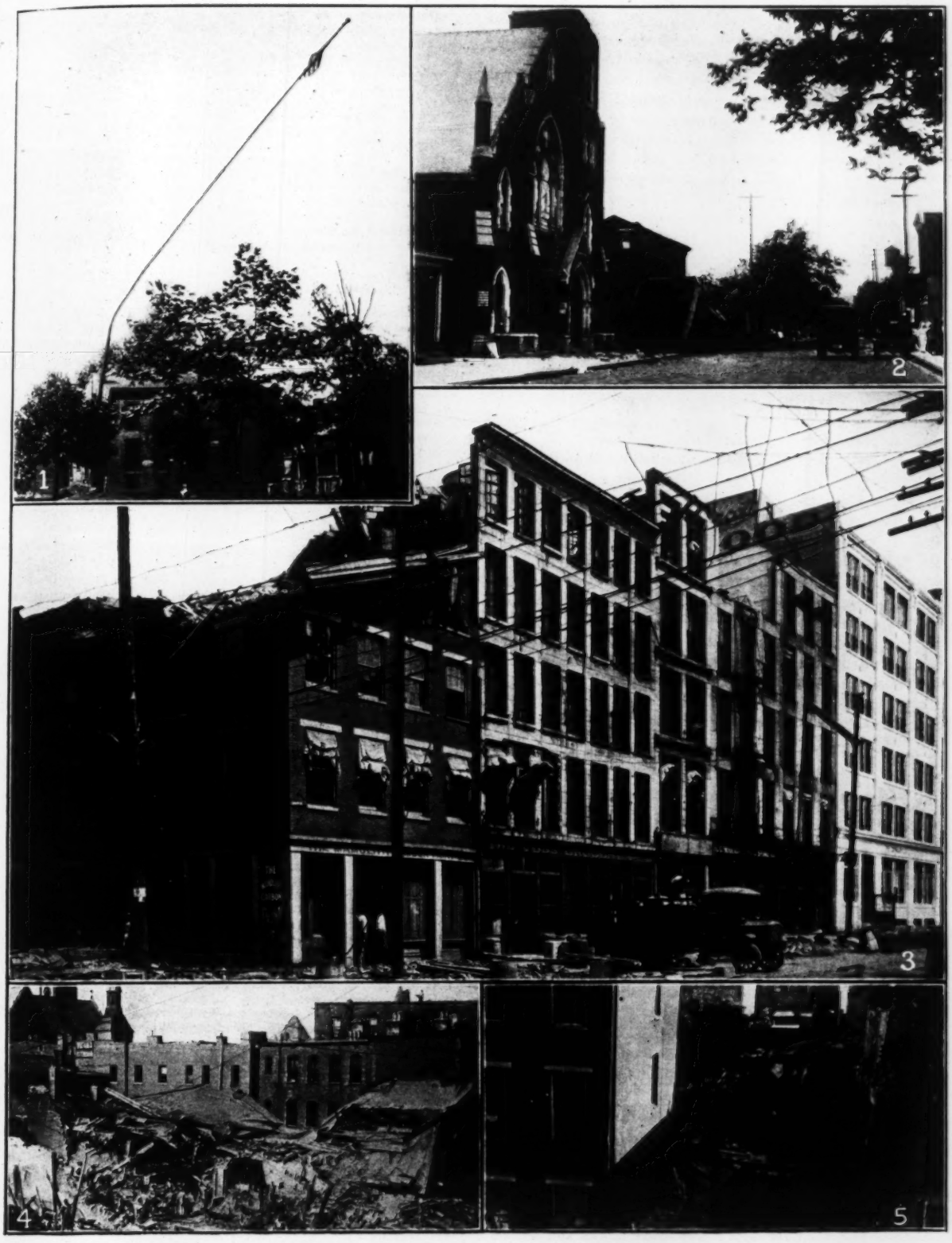
PATH OF STORM THROUGH CINCINNATI AND SUBURBS
Shaded area represents general path of storm. Figures indicate location of views on opposite page

between 9:23 and 9:32 p.m., during which time 0.66 in. of rain was recorded. During the 5 min. ended at 9:32 p.m., 0.53 in. of rain fell, which is very close to the local record for a 5-min. period.

The lightning is known to have struck twice in Cincinnati and once across the river in Kentucky. The electrical display was one of the most brilliant ever observed.

In spite of the popular belief that the storm was a tornado, it is described by the Weather Bureau as a violent wind squall accompanied by excessive rainfall and lightning. All local indications show a straight blow from the northwest. The funnel-shaped cloud with a violent vortex and roaring noise, destroying everything in its path, was not observed. The largest property damage and the greatest loss of life, however, are in localities on a straight line extending from Eighth and Cutter St., through Sixth and Mound, Second and Main, terminating at the Central Bridge over the Ohio, where the steamer "Dick Fulton" sank.

An examination of the damaged buildings leaves the impression that the destruction and loss of life were due to the old and insecure condition of the structures rather than to the severity of the wind. At Eighth and Cutter St., for example (Fig. 5), a three-story residence was crushed by the fall of an adjoining roof, which resulted in five deaths. Immediately opposite is a 6-story reinforced-concrete building that suffered no injury beyond the breakage of a dozen window panes. At Sixth and Mound



FIGS. 1 TO 5. STORM DAMAGE AT CINCINNATI, OHIO, AND NEWPORT, KY.

Fig. 1—Iron flagpole at courthouse in Newport, 10 in. in diameter at base. Fig. 2—Church steeple thrown to ground in Newport. Fig. 3—Second and Main St., Cincinnati, showing destruction in old buildings, and new reinforced-concrete building, in background, intact. Fig. 4—Five or six small buildings destroyed at Sixth and Mount St., Cincinnati. Fig. 5—Three-story residence at Eighth and Cutter St., Cincinnati, crushed by fall of adjoining roof

St. (Fig. 4) five or six old buildings were demolished, with a loss of 14 lives. Some of these buildings are known to have outlived their period of safe usefulness.

The next scene of severe destruction was at Second and Main St., which is about 1 mi. southeast of Sixth and Mound St. Between these points are solid blocks of buildings varying in height from one or two stories to thirty. While there was considerable damage in this area, it was confined almost entirely to the old buildings. The injury to the newer buildings consisted in broken chimneys, firewalls and windows.

The block of buildings on the east side of Main St. between Second and Front St. was badly damaged, with the exception of the Lippincott Building, which is a six-story reinforced-concrete structure (Fig. 3). The old sandstone front, brick and wood-joist buildings, razed for the construction of the Lippincott Building, were very dilapidated, and it is fair to presume that the buildings on either side, which appear to have been built at the same time, over fifty years ago, are not much better. There was no loss of life here, fortunately, because the employees had left several hours before the storm.

Near the Central Bridge over the Ohio River the steamer "Dick Fulton" struck a bridge pier and sank, with a known loss of one life. The 30-story Union Central Building at Fourth and Vine St. and the 12-story Textile Building at Fourth and Elm St., the tallest structures in the path of the storm, suffered very little injury.

After crossing the river the storm did considerable damage—roughly estimated at not less than $500,000—in Covington, Newport, Bellevue, Dayton and the Highlands, most of which was confined to unroofing old buildings, blowing down chimneys and walls, breaking trees, telephone and traction poles. Only one life was lost. The flagpole in Fig. 1 and the church steeple in Fig. 2 show interesting effects of the storm in Newport.—C. M. Stegner, Cincinnati, Ohio.

Kansas Flood-Prevention Conference

A conference on flood prevention in Kansas was held at Topeka last week. About 200 persons were present, including railroad presidents, engineers, mayors and prominent landowners. The conference was called by Arthur Capper, Governor of Kansas, who was elected president of the permanent organization subsequently effected. The vice-president-elect is T. J. Strickler, Engineer of the Utilities Commission of Kansas, and the secretary is J. C. Mohler, Secretary of Agriculture. An engineering investigating committee will be appointed. The need for study of the Kansas flood problem is shown by the fact that the flood losses in that state this year are estimated at $15,000,000.

A Hoisting Chain Broke while steel was being unloaded from a flat-car at the Harrison, N. J., plant of the Crucible Steel Co. of America, on July 1.

A Train Fell on Another Train near Ranier, Wash., on July 3, killing three persons and injuring 16 others. A Chicago, Milwaukee & St. Paul passenger train, bound from Seattle to Graysharbor, went through a weakened trestle and fell upon a Northern Pacific freight train 40 ft. below. A trestle bent had been torn out by a crane arm carried on a car of the freight train. The crane arm had worked loose and caught a diagonal cross-stringer of the trestle. Unsuccessful attempts were made to flag the passenger train.

Derailment of an Electric Car on the International R[illegible] on Queenston Heights, Canada, on July 7 killed 14 persons [illegible]d injured many others. The car, which was an open one, [illegible]as overloaded with excursionists and appears to have exce[illegible]ed a safe limit of speed in passing over a reverse curve [illegible] a down grade. When it left the rails it struck the [illegible]w branches of a large maple tree, which demolished the su[illegible]r-structure of the car. A preliminary coroner's inquest [illegible]as been held and a further hearing will be had on July 19. [illegible]. G. Connette, president of the International Ry., states th[illegible] a representative of the Railroad Commission of Toronto [illegible]x-amined the track and car on July 9 and is reported to [illegible]e found no fault with either. As near as Mr. Connette is able [illegible]o learn, the motorman lost control of the car on account of [illegible]he slippery rails resulting from weather conditions. The [illegible]ar just previous to the wreck had stopped at the foot of a he[illegible]y grade in order that a switch might be thrown, showing [illegible]t the brakes were working. The sandbox was full of sand. The car should have been in first-class condition, having co[illegible]e out of the shops on July 6.

An Alaskan Timber Reservation, 200 miles long and 5 to 10 miles wide, has been created by proclamation of President Wilson to reserve for government use timber that may be needed in the construction of the government railroad in Alaska.

St. Louis Municipal Bridge—The east approach to the bridge has at last been put under contract. The fabrication of the steelwork for the approach was awarded July 9, 1915, to the American Bridge Co. for $1,035,000. The work includes about 24,000 tons of steel. The length of the viaduct is over 3 mi.

A Heavy Rainfall in Boston, Mass., on July 1 broke all records for rate of rainfall for two-hour and five-hour periods. Between 4 and 6 a.m., 2.29 in. of rain fell; between 3 and 7 a.m., 3.37 in. A total rainfall of about 4½ in. for the day exceeded the normal for the whole month of July by about an inch and greatly reduces the deficiency of 6.74 in. since Jan. 1.

The Spring Valley Water Co., of San Francisco, has offered to extend its mains into various suburban districts provided the city withdraws its contest against the rates now charged. At present the rates charged to consumers by the water company are 15% in excess of the rate allowed by the Board of Supervisors. The company also asks an increase of $2.50 per year on the hydrant rental. It is likely that the city authorities will accept the company's proposal.

A Motor Speedway with a brick-paved track, to cost approximately $2,000,000, has been begun near Philadelphia by the Philadelphia Motor Speedway Association. Excavation work has been started on a tract of ground between Old York Road and the Philadelphia & Reading Ry. tracks north of Willow Grove, about 16 mi. from Philadelphia. The track is to be a 2-mi. circuit of brick pavement on a concrete foundation. There are to be reinforced-concrete grandstands seating 100,000 persons and parking space for 30,000 motor cars.

Bronx Valley Sewer Litigation—The United States Circuit Court of Appeals has reversed the action of the lower court and ordered a trial of the suit brought by the American Pipe and Construction Co., of Pennsylvania, to recover $891,952 from the County of Westchester, New York, for alleged extra expenses, due to mistakes in the engineers' plans, incurred by the Mack Paving & Construction Co., contractor on the Bronx Valley sewer. The lower court dismissed the suit on the ground that the whole county was not obligated to bear the expense of the sewer, which benefits only a part of the county. The higher court ruled that the Bronx Valley Sewer Commission is agent for the entire county and the county is responsible for debts incurred by the commission.

The New Union Station at St. Paul, Minn., may be delayed by the refusal of the Chief of Engineers, Gen. Dan C. Kingman, U. S. A., to approve the plans submitted by the city for changing the channel of the Mississippi River in connection with the station. The City Council, in its haste to have work started on the new station, and urged on by the city's business interests, submitted skeleton plans showing only the new harbor lines and lacking in engineering detail. These have been returned and the Chief of Engineers has asked for detailed plans showing the necessary protection of the new river banks and proposed harbor and dockage plans for the accommodation of river traffic and ownership of levees. Early last spring the Union Depot Co. called for bids for changing the channel and held them awaiting the approval of General Kingman. These bids have now been returned to the contractors with the statement that the delay in approval of the new harbor line may make it impossible to start work this season.

PERSONALS

Mr. J. L. White has been appointed Assistant to the General Superintendent of Transportation of the Atlantic Coast Line R.R.

Mr. James G. White, M. Am. Soc. C. E., President of the J. G. White Engineering Corporation, a member of the Board of Directors, has been elected Third Vice-President of the Merchants' Association of Greater New York.

Mr. Ambrose M. White, an Assistant Engineer of the Baltimore (Md.) Paving Commission, has resigned to take a position on the staff of W. D. Uhler, M. Am. Soc. C. E., Chief Engineer of the Pennsylvania State Highway Commission.

Mr. Waldo H. Marshall, M. Am. Soc. M. E., President of the American Locomotive Co., has been elected First Vice-President of the Merchants' Association of Greater New York, to fill the vacancy caused by the death of Mr. Albert Plaut.

Mr. B. F. Cresson, M. Am. Soc. C. E., has been appointed Chief Engineer of the Board of Commerce and Navigation of the State of New Jersey. This board combines the New Jersey Harbor Commission, the Riparian Commission, the Department of Inland Waterways and the Inspectors of Power Vessels.

Mr. R. H. Gould, who is associated with James H. Fuertes, M. Am. Soc. C. E., of New York City, has been appointed Resident Engineer of the new $300,000 sewage-disposal plant at Dallas, Tex. Mr. Gould was formerly with Karl Imhoff at Essen, Germany.

Mr. Irving C. Brower, Assoc. M. Am. Soc. C. E., Division Engineer of the Chicago & Alton R.R. at Bloomington, Ill., has been appointed Commissioner of Public Works of Evanston, Ill. He will succeed Mr. John H. Moore, who has resigned after holding that office for over 20 years.

Messrs. J. C. Workman and A. W. Cross have been appointed to newly created positions of Assistants to Managers of the American Shipbuilding Co. Mr. Workman will have charge of all engine departments, and Mr. Cross will be in charge of the hull departments of the company.

Mr. C. F. Crane, General Superintendent of the Eastern Pennsylvania Ry. Co., controlling traction lines over the greater part of lower Schuylkill and Carbon Counties, Pennsylvania, has resigned and will hold a similar position in Wilkes-Barre. Mr. George R. Williams, Superintendent of the Lansford division, will succeed Mr. Crane, and Mr. T. J. Collins, of Palo Alto, has been made Assistant Superintendent.

Mr. M. N. Baker, Editor of "Engineering News," has resigned from the Board of Health of Montclair, N. J., after serving for 21 years, during eleven of which he was President of the board. On July 1 Mr. Baker became a member and Vice-President of the new State Department of Health of New Jersey.

Mr. Nathan C. Johnson has opened an office in the Singer Building, New Work City, as a specialist in the production of high-grade concrete and in the causes and prevention of defective concrete construction. He has associated with him, as a specialist in reinforced-concrete design and construction, Mr. Walter S. Edge. Mr. Johnson has been engaged for some years in the study of the microstructure of concrete and the relation of that study to the methods of producing good concrete. Mr. Edge has had long experience with a number of contracting and engineering firms engaged in concrete work.

Mr. Albert Russel Erskine, First Vice-President and Treasurer of the Studebaker Corporation, has been elected President. Previous to his association with the Studebaker Corporation, Mr. Erskine was treasurer and member of the executive committee of the Yale & Towne Manufacturing Co. and later vice-president of the Underwood Typewriter Co., which position he resigned in 1911 to go to the Studebaker Corporation. Mr. F. S. Fish, who relinquishes the presidency, becomes chairman of the board, the executive and finance committees. Mr. C. C. Hanch, formerly of the Nordyke & Marmon Co., of Indianapolis, becomes treasurer.

Mr. Frank E. Winsor, M. Am. Soc. C. E., Department Engineer at White Plains of the New York City Board of Water Supply, has been selected as Chief Engineer of the Providence, R. I., Water-Supply Board, in charge of the development of the new municipal water-supply at Scituate. After graduation from Brown University, Mr. Winsor was appointed Engineer of the Massachusetts Metropolitan Sewerage System, having charge of the system embracing Boston and surrounding cities. Later he was Resident Engineer of the Natick, Mass., Sewerage System. In 1903 he became connected with the additional water-supply projects of New York City. Since 1910 Mr. Winsor has been Division and Department Engineer on the Catskill water-supply, in charge of construction in the southern aqueduct department.

Mr. G. R. G. Conway, M. Can. Soc. C. E., has resigned as Chief Engineer of the British Columbia Electric Ry. Co., Ltd., Mr. Conway has been appointed Consulting Engineer to the company, and in addition intends to take up private practice in Toronto. Previous to his association with the British Columbia railway, Mr. Conway was Consulting Engineer in connection with the construction of the Coquitlam dam for the Vancouver Power Co., and prior to his work in British Columbia he represented Mackenzie, Mann & Co. as Chief Engineer for the Monterey Railway, Light & Power Co. and the Monterey Water Works & Drainage Co., of Monterey, Mex. Mr. Conway was educated at the Hartley University College, Southampton, England. On leaving college he became assistant to the late Mr. James Mansergh, a former president of the Institution of Civil Engineers, and later Resident Engineer of the City of Aberdeen. Mr. Conway expects to open his Toronto office at the end of July.

OBITUARY

Louis C. Gaby, Civil Engineer of the Madison Coal Corporation, of Madison, Ill., died at his home in Edwardsville, Ill., on July 3, at 29 years of age.

John Grey Hoben, a civil engineer employed by the New York State Public Service Commission, died in Long Island City, N. Y., on July 6, at 31 years of age.

Samuel H. Lockett, formerly Chief of the Engineering Department of the Continental and Fidelity-Phenix Insurance Co.'s, died at his home in East Orange, N. J., on July 4.

George G. Kennedy, for 20 years Superintendent of the Harrisburg, Penn., Water Department prior to the inauguration of the commission form of government, died in that city on July 3 after a long illness. He was 51 years of age.

Robert Childs Scott, Secretary-Treasurer of the Morris Machine Works, of Baldwinsville, N. Y., died suddenly on July 3, in his 67th year. Mr. Scott was born at Oswego, N. Y., and received his education in the Oswego schools and Hobart College, at Geneva, N. Y. He entered the office of the Morris Machine Works in 1885, and on the incorporation of the company in 1892 became its Secretary and Treasurer.

Ernst Schild, who was in executive charge of the military construction works of the German War Department for a quarter of a century, died at his home in Charlottenburg on May 21 from a stroke of paralysis. He was in his 62nd year. Major Schild's works covered a wide field, from the building of military hospitals and sanitation to the water-supplies and drainage of large military communities and the designing of entire military towns for the assemblage of troops. He was a member of the Advisory Committee of the German Ministry of War.

Joseph A. Holmes, M. Am. Inst. M. E., Director of the United States Bureau of Mines since its creation in 1910, died July 13 in Denver, Colo., from tuberculosis. He was born at Laurens, S. C., Nov. 23, 1859. He was graduated from Cornell University in 1881 with the degree of B. S., and was subsequently awarded doctors' degrees by the Universities of Pittsburgh and North Carolina. He was Professor of Geology and Natural History at the University of North Carolina from 1881 to 1891 and State Geologist of North Carolina until 1904. From 1904 to 1907 Doctor Holmes was in charge of the United States Geological Survey laboratories for testing fuels and structural materials at St. Louis, Mo. He was then made Chief of the Technological Branch of the Survey in charge of the investigation of mine accidents, the work which was placed under the new Bureau of Mines in 1910.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

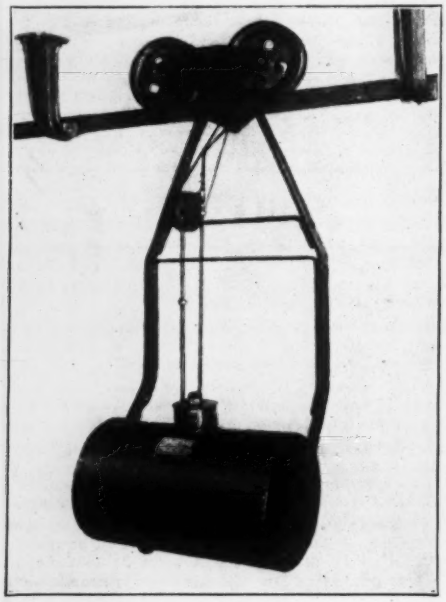
INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 24-27. Annual convention in Cincinnati. Secy., Clarence R. George, Houston, Tex.

San Francisco Conventions—The technical societies meeting in San Francisco from Aug. 19 to Oct. 20 were published in "Engineering News" July 1, 1915, p. 44. The list will be published again in an early issue.

Appliances and Materials

Cable-Oiling Car

To protect the track cables of aërial wire-rope tramways from corrosion, and to reduce the wear and friction, it is necessary to keep them thoroughly lubricated. Oiling from buckets by hand is practically out of the question, especially on long tramways. The accompanying view shows an auto-



CABLE-LUBRICATING CAR

matic track-cable oiler furnished by the Broderick & Bascom Rope Co., of St. Louis, Mo., for the maintenance of its aërial tramways.

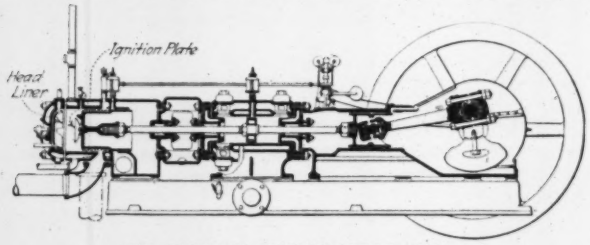
The device consists of an oil tank attached to a hanger and carriage in the same way as the regular bucket, and having a small geared centrifugal pump driven from one of the trolley sheaves. The oiler grips the hauling cable and is sent over the line in the same way as a bucket. As it travels along the oil is pumped up and sprayed on the track cables.

For the lubrication of the hauling line, this cable is passed, at the end of the line, through a box which has a grooved sheave, with its top above the surface of an oil bath. The cable takes up oil from this sheave and then passes between a pair of stiff wire brushes, by which the excess oil is removed and dropped back into the bath.

* * *

Oil-Engine Air Compressor

Because of the demand for an engine-driven air compressor taking cheap fuel, the Chicago Pneumatic Tool Co. has recently developed a design employing a two-cycle low-compression fuel-oil engine operating on anything between gaso-



OIL-ENGINE COMPRESSOR UNIT

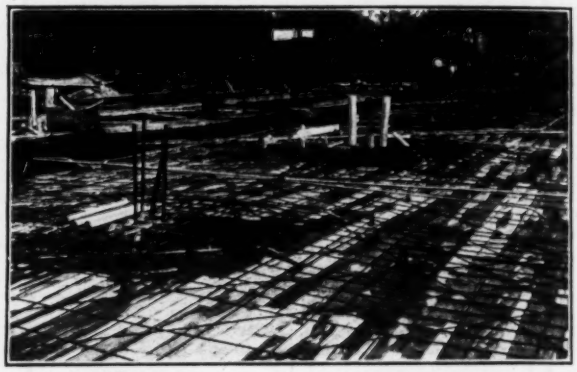
line and crude oil inclusive. The engine cylinders are valveless and carry integral water jackets over combustion spaces. Heads are single castings with jackets. The piston carries four spring rings and a charge deflector. Relatively high compression is given in the crank-end case. Only air is compressed in the power cylinder, the fuel being injected, the end of the compression stroke, against a thin hot-plate the piston. In starting, a torch-heated tube ignites the charge. The fuel pump stroke is controlled by a flyball gover, a needle valve, injecting water in with the fuel, is also governor-controlled.

The air cylinder and heads are water jacketed; the air piston carries two spring rings. Discharge valves in the bottom permit the escape of excess lubricating oil. Flat-disk, high-speed inlet and discharge valves are set radially in the cylinder. The air cylinder is unloaded on light loads by automatically holding the inlet valves open. The frame is fully inclosed, with access given by side and crank-case covers. The main bearings are integral with the frame and are babbitted. The shaft has a center counterbalanced crank of forged steel. The connecting rod is forged and has a solid wrist-pin end with bronze boxes; the crank end is babbitted. The cylinders carry sight-feed lubricators.

* * *

New Flat-Slab Floor

A new and improved type of girderless floor or flat-slab construction, known as the "spiral mushroom," is now being built by the C. A. P. Turner Co., of Minneapolis, Minn. The reinforcement consists of (1) a flat spiral over the column head, (2) slab rods running parallel to the columns and crossing over the column heads, and (3) diagonal bands running from midspan to midspan, thus not touching the column head reinforcement. According to the inventor, C. A. P. Turner, the new system "obviates the disadvantage of the cob-piling of the reinforcement in the old type and permits a more compact



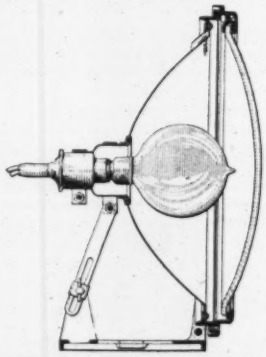
SPIRAL MUSHROOM FLAT-SLAB FLOOR

arrangement of the reinforcement resisting negative bending. The flat spiral, by circumferential stresses, resists radial deformation with considerably greater efficiency than radial reinforcement, and the slab steel is by this arrangement placed in much thinner layers, with greatly increased efficiency. The diagonal belts perform the function of ring ties, and by reference to the flat-plate theory it will be seen that they traverse the zone in which horizontal shear in vertical planes is the greatest."

* * *

Projection Lamp for Exteriors

To meet the demand for equipment adapted for flood-lighting of architectural exteriors, the General Electric Co., of Schenectady, has designed the projection lamp shown in the accompanying sketch. A polished aluminum parabolic reflector is mounted in an iron frame and closed in front with a plate of heat-resisting glass set in a waterproof packing. The reflector support is pivoted to a base plate, so that the axis of the beam can be shifted through various angles; a slotted link holds the reflector and base locked. The illuminant most commonly used is a 500-watt 1000-cp. gas-filled tungsten unit with concentrated filament. By moving the lamp in or out of the reflector the spread of the projected beam may be varied from 6 to 18 deg. The lamps are placed from 25 to 500 ft. from the surface to be lighted—on a roof, side wall or pole.



SECTION THROUGH PROJECTING LAMP

Engineering News

VOLUME 74 JULY 22, 1915 NUMBER 4

Stepped Concrete River Wall at Harrisburg, Penn.

By Joel D. Justin*

The City of Harrisburg, Penn., has just completed the construction of a stepped reinforced-concrete retaining wall along the Susquehanna River about 2½ miles long. The prime purpose of this wall was for the protection from ice and flood of an intercepting sewer along the river front that was completed in 1913.

The river front of Harrisburg constitutes the best residence section of the city, and throughout most of its length there is a narrow strip of parking on top of the river bank, which varies in height from 15 to 20 ft. above low water.

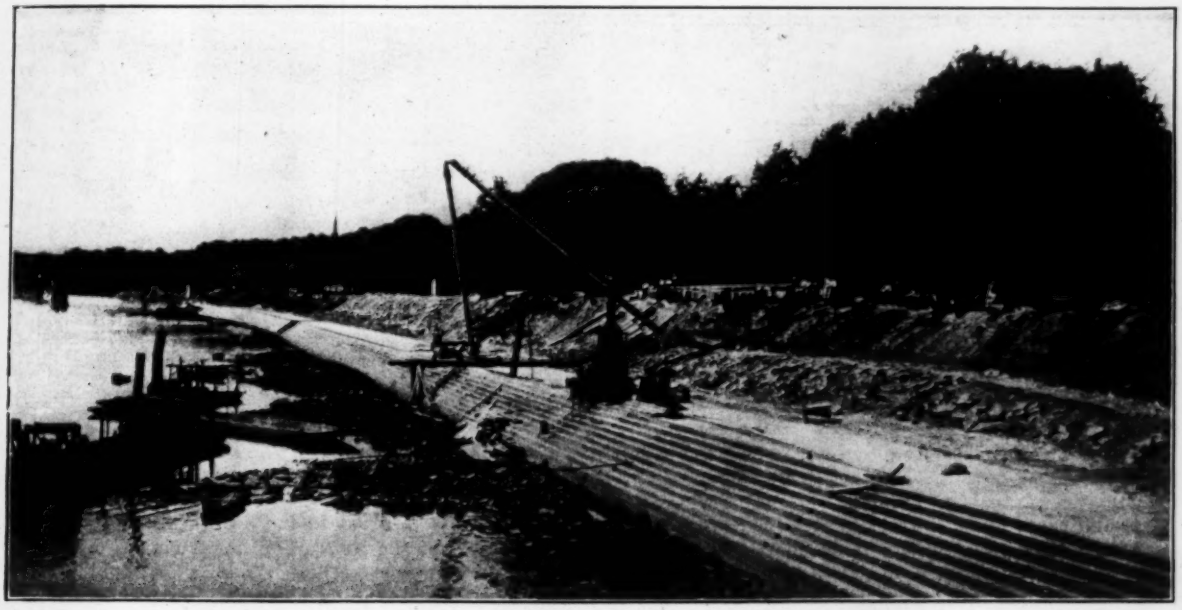


FIG. 1. THE PARTLY COMPLETED RIVER WALL ON THE SUSQUEHANNA AT HARRISBURG

With the completion of the dam across the Susquehanna River at the lower end of the city, it is expected that motor boating and canoeing will become very popular. Accordingly, it was decided to construct the wall in such a manner as to make it an integral part of the park system.

The position of the wall was so chosen that at minimum low water there will always be water at the bottom step of the wall. The grade follows very closely the gradient of the river at summer stages. The alignment consists of a series of long tangents and gradual curves throughout the river front of the city. With two exceptions the curves are all 1° and 2° curves, making the effect very pleasing to the eye.

At several points along the line of the wall it was necessary to provide landing places for the accommodation of parties engaged in the dredging of sand and coal from the river. At such points a cantilever reinforced-concrete retaining wall 8 to 10 ft. in height was used.

Throughout the entire length of the wall, removable electric-light posts are provided for, spaced 104 ft. c. to c. In the fall, when floods may be expected overtopping the wall, these posts can be disconnected and removed.

Concrete buttresses spaced 8 ft. c. to c. and 12 in. thick were built to rock throughout the length of the work. These buttresses carry the reinforced-concrete steps and are fastened to them by ⅝-in. square quill bars set in the stringers and projecting into the steps. The latter have a 7-in. rise and 10-in. tread and vary in number from 9 to 14. Below the bottom step is the footwall, which in all cases runs down to rock and is fastened to the buttresses by ⅝-in. square quill bars. Back of the steps a 14-ft. granolithic sidewalk was constructed. The total height of the wall thus varies from 7 to 10 ft.

*Principal Engineer, Board of Public Works, Harrisburg, Penn.

The concrete buttresses were cast first, then the fill was made to approximate line and grade and the reinforced-concrete steps were cast in 8-ft. sections, the entire flight being poured in one operation. These steps were built in alternate sections. At one end of the section they were fastened to the buttresses by the 5/8-in. square bars, as described, while the other end was free to move horizontally, being merely beveled under the next section. Thus each 8-ft. section was a unit held rigidly in place at one end to the buttress, but free to move horizontally at the other end, although held in place by the bevel mentioned. The expansion joints thus located 8 ft. apart were greased with petrolatum to prevent adhesion of the concrete when the alternate section was poured. The use of this material also gave a slight but appreciable space between the sections. Each step was reinforced with two 5/8-in. square bars at the back and two 3/8-in. square bars at the front, against ice pressure from the river and earth pressure from the retained fill.

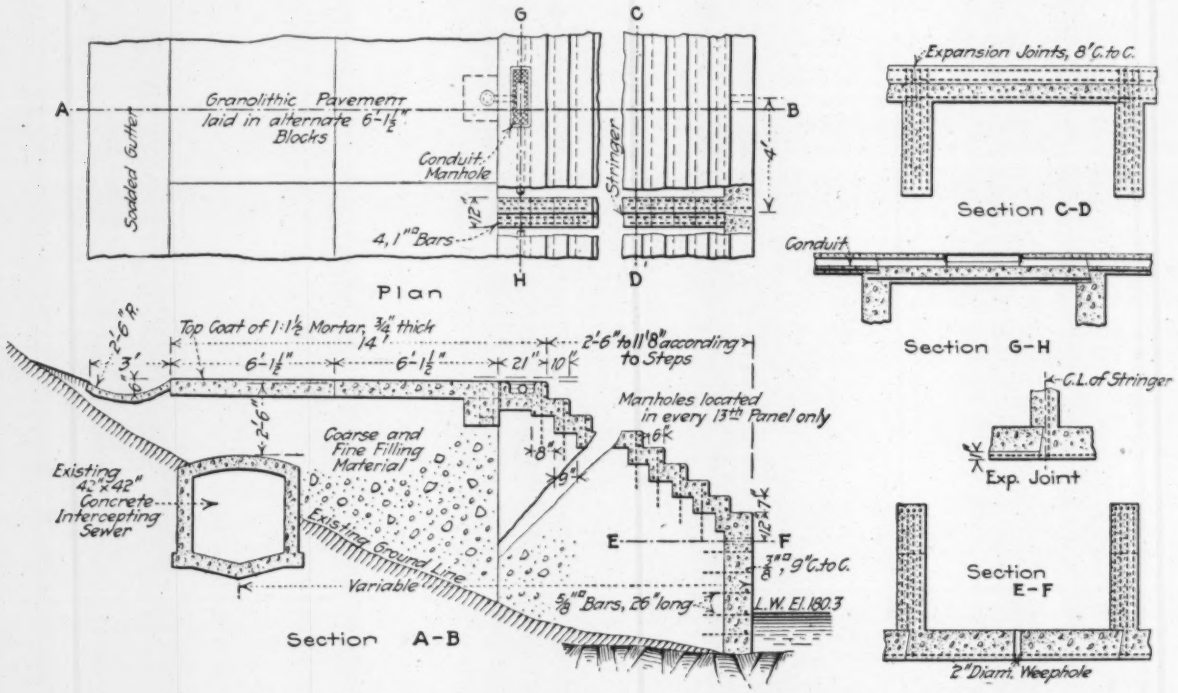


FIG. 2. DETAILS OF STEPPED RIVER WALL AT HARRISBURG, PENN.

All concrete was mixed in the proportion of 1 part of cement, 2½ of sand and 4½ of crushed stone. The sand used was Juniata River sand and was excellent in quality, except that the grading of the particles from fine to coarse was poor, 80% passing the 30-mesh sieve and only 4% the 50-mesh sieve. The deficiencies in this sand were largely compensated for by the finer particles of the run of crusher stone. The crushed stone used was limestone from local quarries, maximum size 1 in.

The concrete in the buttresses, footwall and special retaining walls was mixed wet and thoroughly spaded. That for the steps and sidewalk was mixed so dry that considerable heavy ramming was necessary to make moisture come to the top. The steps and sidewalk had a wearing surface composed of 1 part cement and 1½ parts sand.

In the construction of the buttresses wooden forms were used. During the first season these were built up and torn down for each individual buttress. Inasmuch as there are some 1500 of these buttresses all of the same design and varying only in the number of steps provided for and in depth, this proved to be a very expensive method. About 500 buttresses were erected in this manner. The following season the panel system of forms was adopted and the forms were moved from buttress to buttress as the work progressed.

Sand, stone and cement were delivered along the line of the work by wagon. A ½-cu.yd. mixer, with cantilever arm and traveling concrete bucket, was used in concreting the stringers.

In the construction of the steps wooden "horses," or templates, set to line and grade and clamped on the top of the buttresses, were used. The forms to secure the beveled expansion joints were attached to these horses. To the risers of these horses were attached the riser boards of 2-in. plank lagging 7 in. wide, stiffened with 2x2x¼-in. steel angles. These risers were held in place by adjustable bolts fastened to the horses. The only bottom forms used for the steps were some strips of 1-in. plank used to retain the earth at the rear of the steps while the concrete was being placed. These were removed after part of the concrete had been placed. For the rest, the concrete was deposited on the earth embankment. The mortar surfacing for the risers was placed while the concreting was in progress by plastering the riser boards with mortar, care being taken to keep the mortar surfacing ahead of the concrete. The concrete and mortar surfacing, both of which were placed rather dry, were tamped together with small tampers. The concrete for the steps was mixed in a one-bag batch mixer, but it was found necessary to mix all mortar top coat by hand.

While fair alignment of the step forms and risers was attained, it was secured at the cost of a great deal of trouble and it is believed that money could have been saved by the use of steel horses and riser forms, which could have been more readily kept in line.

FIG. 3.-LOOKING ALONG WALL DURING CONSTRUCTION

In the construction of the embankment all earth outside, and for a depth of 2 ft. below the top, of the footwall was required to be excavated. The remainder of the filling material came from borrow-pits along the line of the work and elsewhere at points specified by the engineer. No payment was made for embankment, but material was measured and paid for in excavation. The contractor was required to give 1500 ft. free haul, and allowance was made for any overhaul required at the price specified in the contract per 1000 ft. overhaul per cubic yard. A 20-ton shovel and bottom dump wagons were used for making the fill.

The construction of the sidewalks was carried on in 6-ft. alternate blocks, with a wearing surface of mortar ½ to ¾ in. thick, with expansion joints located 36 ft. apart. The method of placing this wearing surface on the steps and sidewalk is worthy of attention, as it is the only method, aside from the cement-gun, that absolutely assures the permanent adherence of the mortar wearing surface to the concrete base. The latter, whether sidewalk or steps, was placed so dry as to require considerable heavy ramming to bring moisture to the surface. The mortar top coat is mixed so dry that when a ball of it is formed in the hand it must be squeezed quite a bit in order to make water come to the surface. This top coat is then spread over the concrete base within a half-hour of the time of placing the latter, and is rammed and screeded into place. The surface is then finished at once with wooden floats and metal trowels. When the top coat is placed by this method with proper attention to details, it will never come off.

The writer has removed slabs placed in this manner and found that there was no dividing line between the top coat and concrete. In fact it was found impossible to separate the top coat from the base, the fracture occurring elsewhere in every case.

The contractor's plant consisted of a 20-ton shovel, one two-bag batch mixer, self-propelling and operated by steam, and one one-bag batch mixer operated by gasoline. At different times there were two additional mixers on the work, and of course there were the usual wheelbarrows, small tools, etc. Teams and wagons were hired by the day.

The quantities involved and the contract prices were as follows:

12,000 cu.yd. 1 : 2½ : 4½ concrete, at	$7.29
330 tons of reinforcing steel, at	50.00
12,000 lin.ft. of fiber conduit, at	.06½
12,000 lb. cast iron, at	.08
12,000 cu.yd. of excavation, at	.60
45,000 cu.yd. of excavation, at	.70
43,000 cu.yd. 1000-ft. overhaul, at	.08

The total cost of the work will be about $160,000.

The price of concrete is considered very low for this class of work, but the price on excavation was ample. Inasmuch as the contractor secured much of his material from excavations where he was also paid for doing the excavating by other parties, it is believed that he did not make out so badly on the contract as a whole after all.

The work was done by the Stucker Brothers Construction Co. of Harrisburg, under the direction and plans

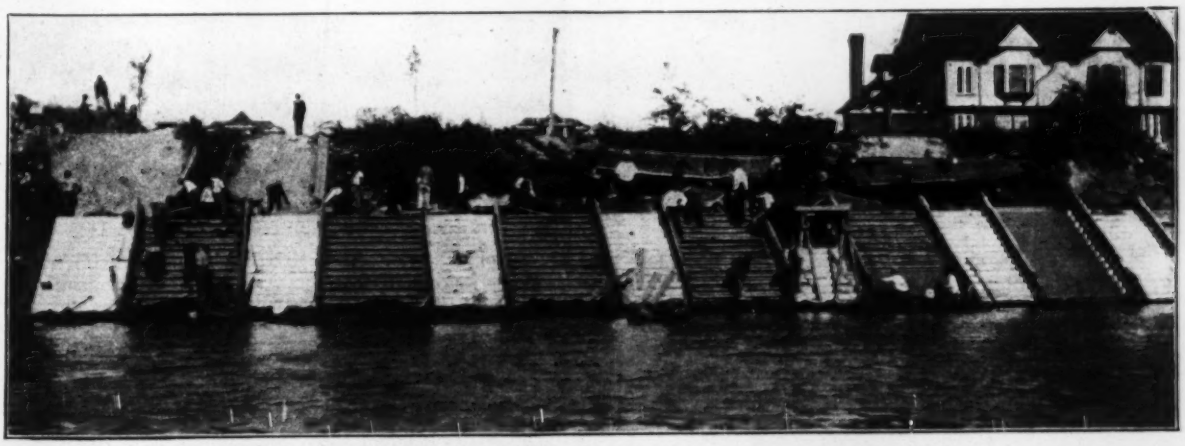


FIG. 4. ALTERNATE STEP FORMS IN PLACE ON HARRISBURG RIVER WALL